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Works Testing and its Limitations.

It is a puzzling but common occurrence that two men of long experience in the same field of work may reach entirely different conclusions on a point of fact. It is usually assumed that "facts is facts," and that there can be no two honest opinions about them, but this is only true "other things being equal," as the economists say, and in practice other things seldom are equal.

A simple analogy makes the position clear. Two gardeners are given hyacinth bulbs, tested and known to be identical in every respect. They plant them, and are surprised to find six months later that their results are entirely different. Clearly the reason is that the conditions operating are not the same. One bulb may have been planted in a sunny, sheltered border and good loamy soil, the other in an exposed position and clayey ground. Moreover, although both gardeners employ the best technique known to them, it will not be the same technique. The only way to ensure identical results from identical fact beginnings would be to grow the bulbs under the artificially-induced conditions of a greenhouse, cared for by the same expert and given an exact duplication of treatment.

Now apply this to the works. In no two cases are conditions exactly identical, nor do any two men base their methods and technique on identical experience. A man takes for granted the conditions under which he works, to such an extent indeed that he is probably not conscious of them—so does the other man, but in his case it is a different set of conditions that is taken for granted.

The limitations that experience imposes are felt especially in the case of works testing. Large-scale tests are an invaluable guide to the results to be expected from a given set of conditions: one test under one set of conditions is hardly any guide at all to work under other conditions. Tests that are to be of universal application must be carried out under conditions which can be analysed and specified in detail, so that each individual in applying them may make allowances for necessary differences in his own case. It is only under such artificially induced and regulated conditions as those of the laboratory that the same fact-beginning can be relied upon to produce the same results only there can the same conditions be secured at different times.

It follows that a process, a method, or a material may be brilliantly successful in one foundry and a dismal failure in another. It also follows that no new process or material can be expected to be universally successful. Over and over again the result of one full-scale trial fails to come up to expectations, while another succeeds; the reason seems to lie outside the individual's experience, and even a consultant also may fail to discern the differences at work, with the result that the material or process is condemned and praised by people who ought to know. The practical man has at least this advantage over the theoretical man, that he does recognise the possibility of a nigger in the wood-pile; if he succeeds in finding the nigger, by so much is his experience broadened. In other words, if he can find the cause of the differences in practice he has largely solved the difficulty they create.

The experienced man, indeed, who realises that his experience will not carry him all the way, is on the road to overcoming his limitations: the real trouble lies with those who fail to appreciate the existence of such limitations.

"Mass" the Meeting Point.

We admit to a certain amount of surprise at the general support received by Mr. Shaw from his critics. It is obvious from a complete survey, such as is now available, that there is a demand for research on cast iron as cast iron, and not in the form of a non-carbon-silicon-"x" alloy made from a Swedish iron base. But when one operates on such materials, special conditions arise, which we have deemed worthy of special treatment in the adjoining column. In any consideration of large-scale research on cast iron any worker will, before he has proceeded any distance, be loud in his demands for an accurate equilibrium diagram to find a *raison d'être* for any conclusion at which he may have arrived. On more than one occasion when calculating the thermal efficiency of a furnace have we lost confidence in our results owing to the non-existence of reliable basic data at elevated temperatures. Candidly, we regard research on cast iron, whilst neglecting or discontinuing work on pure material combinations, very much like starting away on an exploration without a compass and other instruments. Obviously, discoveries of the greatest value may be made, but only at increased cost due to irrational method.

Another aspect is that insomuch as any modern worker must use the technical terms evolved by the theorist, he must have encountered the phrase "influence of mass." Herein, to our mind, is the key to the solution of the problem posed by Mr. Shaw, for the inference is reversible. Mass, as is well known, introduces new aspects to any problem by influencing rate of cooling, static pressure, the chemical reactions and physical properties, liquation, segregation, etc. A deeper study seems to indicate to us that there is a definite, urgent and imperative need for *co-operative research* on the influence of mass jointly sponsored by the academic workers (working up from small quantities to larger ones, whilst retaining scientific accuracy), and works metallurgists working down from large masses to small whilst still retaining their cardinal point of practical applicability. Long before such a research was completed the questions of inherency would be solved.

So far as Part II of Mr. Shaw's Paper is concerned, we would merely point out that as an industry we must preferably tell outside interests of our successes, and solve our own problems ourselves. The moment we can "blind our customers with science"—that is, of course, real science, free from chicanery—then, and then only shall we be "masters in our own household."

XUM

Modern Handling Equipment.

An Interesting Development in Great Britain.

Particularly noteworthy in connection with the conveying and handling of coal, coke, sand and other material, is the fact that Messrs. The Underfeed Stoker Company, Limited, have now taken over the sole manufacturing and selling rights in Great Britain and the British Empire of the well-known "Beaumont" equipment, which is being made throughout at their Derby Works.

The field covered is very extensive, and apart from foundries and power plant, some of the many other applications are in cement works, gas works, glass plants, sugar refineries and similar applications for the handling of coal, ash, coke, sand, limestone, and crushed ores, to mention a few examples.

Interesting to foundries is the "Beaumont" electric driven automatic skip hoist, which consists essentially of a steel bucket, overhead cable track and winch, the whole operation of the raising and lowering of the bucket from the ground level, and the conveyance along the wire cable overhead, being carried out by hand control on the ground, while the equipment includes a special magnetic brake which holds the bucket dead-tight at any point in the travel, in case, for example, of the failure of the electric current.

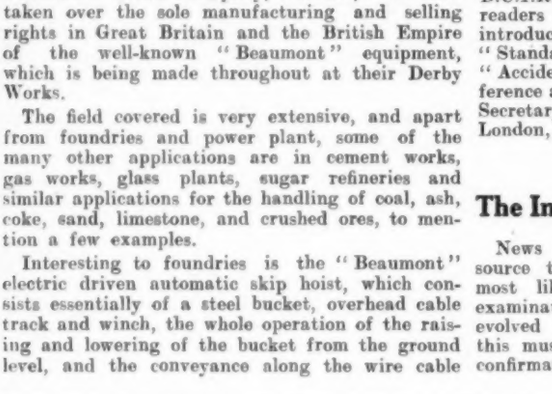


Fig. 1.—The "Beaumont" Electrically-driven Automatic Skip Hoist for Use in Foundry Stock Yard.

For coke or coal storage the "Beaumont" cable drag scraper is particularly applicable, being made in standard sizes from 80 to 600 tons per hour capacity, taking it off the pile or putting it on as required, with an average haul up to 100 feet, utilising any area of site, circular, square, or irregular. The essential principle is that of a heavy steel bucket or scraper, which lies on the top of the coal pile, partly penetrating, and by means of an endless cable is caused to pass backwards and forwards over the entire surface, fixed to a tower at one end, and at the other a suitable post or, for large installations, a moving travelling carriage device running on rails round the outside of the entire storage area, clamped down at any desired spot. The whole arrangement is electric driven, and the large travelling cable scraper rapidly pulls the coal off the pile or deposits it again from wagons tipped on to a dump, as operated by an electrically operated winding device, the attendant having full view of the pile, while the installation also includes a travelling skip hoist and the overhead tower mentioned with a chute. At present, for example, there is being manufactured at Derby a complete "Beaumont" cable drag scraper equipment, having a capacity of 70 tons of coal per hour, and many advantages are claimed for this general principle as against overhead telphers and cranes (steam or electric), especially as regards low capital costs, simplicity and flexibility.

A.S.L.I.B. Conference.

The Association of Special Libraries and Information Bureaux are to hold their Fifth Annual Conference at New College, Oxford, from September 14 to 17. Dr. R. S. Hutton (Director of the British Non-Ferrous Metals Research Association) will succeed Mr. J. G. Pearce (Director B.C.I.R.A.) as Chairman. Of interest to our readers are sessions on "Scientific Abstracts," introduced by Dr. W. Rosenhain, F.R.S.; "Standardisation in Bibliographic Methods," and "Accident Prevention." Details of the Conference are available on application to the General Secretary, Mr. S. S. Bullock, 26, Bedford Square, London, W.C.1.

The International Test Bar Situation.

News has just reached us through a private source that the American foundry industry is most likely to adopt three test bars for the examination of cast iron on similar lines to that evolved by the British authorities. Naturally, this must be accepted with reserve until official confirmation is forthcoming.

Derby Foundry Sports.

Everything possible is done by the directors of Messrs. Haslam's Foundry Company, Limited, of Derby, to encourage friendliness among their employees, and the sports held on the Normanton St. Giles' recreation ground, Sunny Hill, proved quite a success. There was a large number of persons present, including the managers of the various departments of the firm as well as the directors of the Company. No fewer than 500 entries have been received for the festival, as it is called, which is the first held since the re-formation of the Company last year. The Derby Derwent Brass Band was engaged, and at the conclusion of the sports played for dancing.

The various events were well contested.

Death of Mr. Louis Le Chatelier.

We regret to announce the death of Mr. Louis Le Chatelier. In his early days he was connected with Anciens Etablissements Cail, but he undoubtedly established himself as a leader of French metallurgical thought during his 30 years' connection with Société Française de Constructions Mécaniques. He was one of the founders of the Société Métallurgique de Normandie, which was established in 1921, and now ranks amongst the finest equipped iron and steel works in Europe.

Mr. James D. Ward, of Oaklands Road, Wolverhampton, senior member of the firm of Messrs. Ward & Sons, sanitary engineers, of Wolverhampton, died recently.

Random Shots.

"Except in the heavy industries," I read the other day in one of those journals so popular with the lady typists in our midst, "the country has never been more prosperous." The comment—which purported to come from a member of the Government—went on to give as illustrations the fact that the number of National Savings Certificates has doubled in the past eight years, while nearly 400,000 more persons are employed in the insurable industries now than in 1920. I don't deny these facts, nor yet do I deny that they are signs of prosperity of a kind, and they would clearly be of great interest to the aforesaid lady typists in view of the added explanation that most of the 400,000 are women. But it seems to me that to talk of the country being prosperous *except* in the heavy industries is rather like saying, "Oh, yes, I've a splendid appetite. Of course, I never have any breakfast, nor any dinner, nor any supper, but otherwise I'm eating splendidly!"

* * *

I am a great believer in giving the widest possible publicity to statistics of a really encouraging nature, for I incline to share the economists' view that belief in a satisfactory state of trade goes some way towards ensuring it, because it establishes the necessary atmosphere of confidence. But this kind of statement, intended as it is for an almost entirely uncritical and uninformed public, can only do harm.

* * *

Not very long ago the only part played in journalism by the distinguished amateur was the gracious loan of a signature by "Lady So-and-So, the popular "hostess," to an account of "How I Make my Guests Feel at Home," or by Miss Luella Lipstick to an exposition of "Why Some Girls Succeed on the Stage." But the recent controversy over the journalistic activities of Cabinet Ministers is a sign of the times. It is permissible to-day not merely to provide your signature, but to provide the article as well. A number of journals, chiefly the better type of illustrated weeklies and monthlies that cater for women, are apparently paying handsome sums to eminent people for really authoritative articles on serious subjects.

* * *

This development was brought home to me by an announcement in one such paper. It is staging a series of articles by various eminent people on different aspects of the education-and-careers problem, among the contributors being Sir John Reith, of the B.B.C., Professor Gleadowe, of Oxford, and H. T. Tizard, F.R.S., of the Department of Scientific and Industrial Research. The latter will write on "Scientific Research and the Training it Needs." Surely it is something of a novelty for the secretary of a Government Department to contribute to a symposium of this kind!

* * *

More Shakespeare in the Foundry.

First Moulder: By all the stars that glisten overhead,
By all the flowers that blossom in the meads,
And all the birds that twitter at the dawn—
I swear I am most fearfully athirst!

Second Moulder: In very truth until thou spakest, good friend,
I knew not whence this pestilential weariness
That o'er me creeps had sprung. But now let's haste
And seek some consolation for this ill
Beneath the sign of Lion and of Bull.

"Marksman."

Loam Moulding.

By J. E. P.

To excel in the art of loam moulding a man must have imagination and vision, enabling him to have a sound conception of the whole contrivance necessary to bring the piece of work to a successful issue; in short, to quote an old moulder, "Make the job in your mind before you make it in loam."

A fair knowledge of bricklaying is necessary, as there is a similarity between bricklaying and loam moulding; the bricks must be crossed and tied with bars and binders—loam being used as is mortar in house building—thus ensuring stability in the whole structure and strength to resist the liquid pressure of the metal at the time of pouring.

Loam varies greatly according to the locality from which it is obtained. That there are many sands suitable for loam moulding there is no question, and it is wise to try local supplies before obtaining them from afar. For instance, a very large firm of founders in the Midlands always bought the sand from abroad, and were satisfied it was the best, the like of which could not be procured in England. Then came the great lamentable war, and the source of supply of sand from abroad was cut off. Many other kinds of sands were tried, but none gave the desired results until someone suggested trying the sand from the hill just outside their own works. This was at once done, and not only was it found to be an excellent moulding sand suitable to their requirements, but there was a good supply; in short, it was every bit as good as that from afar, if not better, and it was most certainly cheaper.

In a second case the main road was being dug up, just outside the foundry, for drainage purposes, and the sand, about 4 ft. down from the road's surface, was really a good moulding sand, and the municipal authorities were only too pleased for the foundry people to cart this sand away, which, of course, they did, and stocked their yard with it.

The site upon which the works were established was rich in moulding sand, about 3 ft. from the surface; not only was a good supply of sand ensured, but the space formed by abstracting the sand made a good dumping ground for all refuse, slag, ash, and rubble of all kinds.

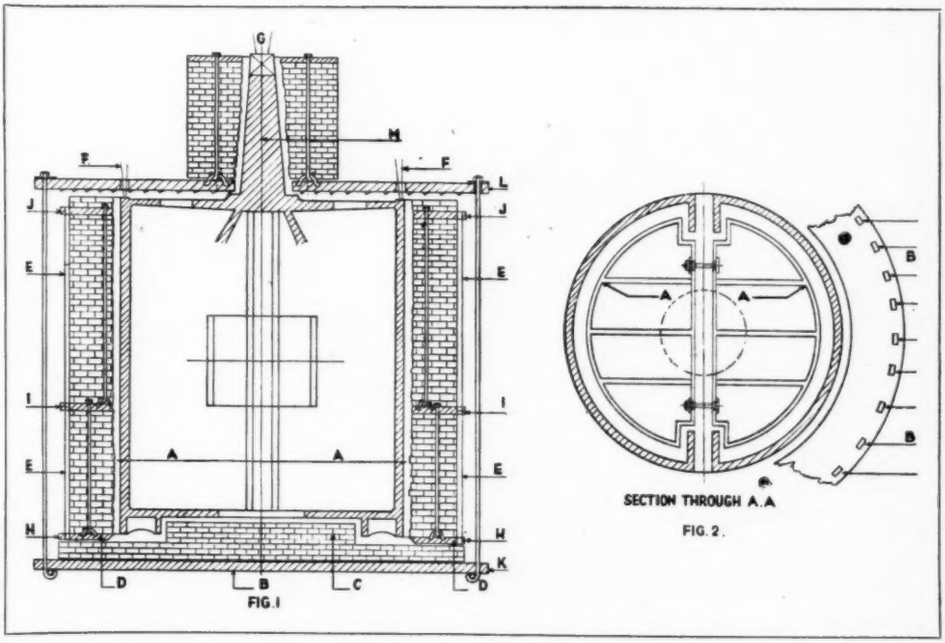
Loam moulding is the highest class of all moulding, yet sand moulding is far more difficult and much more risky.

In cases of repetition work loam moulding should not be resorted to, because dry-sand moulding is now almost perfect, and is much cheaper and nearly as sound a process. Dry-sand moulding is moulding in a strong green sand; when drying the mould thoroughly a good mixture of sand for this purpose is a quantity of ordinary loam, dried in the stove, spread out on plates, then mixed—after drying—as a facing sand, so that it can be rammed. On the other hand, loam moulding will never entirely be dispensed with, as there will always be some jobs which call for this method of moulding.

The illustrations, Figs. 1 and 2, show an axle for a large gas exhauster moulded in loam. Fig. 1 shows the casting and mould in section. K, B is the foundation or bottom plate, which, of course, must be very strong and rigid, with the necessary lugs for lifting, and holes for bolting the whole mould together. These foundation plates are usually made by the loam moulders and are cast "open-sand." Care should always be taken to cover them immediately after casting or pouring with a covering of sand about 9 in. thick, otherwise if the cold air plays on the top side of an open sand plate it is almost certain to crack by uneven contractions. There is not much labour costs involved in making tackle for a job like this, but the quantity of iron required is sometimes—in fact, more often than not—greater in weight than the actual casting; but as the metal of the tackle can be used after the casting is made, there is only the labour cost and the cupola charges really involved. The system of charging all costs of tackle to the job in hand is certainly wrong. It has been said that the ultra-modern costing department tokes count of every minute and every pound of material expended upon a job. So far, so good, but to charge all tackle and time and material to a particular job is preposterous, if the labour and material are charged up and carry overhead and establishment charges as well.

Quite often the tackle weighs more than the casting; therefore, to debit the foundry with the entire cost of tackle at casting-selling price, is stupid in the extreme, and rules out competitive quoting.

C, Fig. 1, shows the bottom course of brickwork kept back from the face of the mould about 2 in., so that the loam facing may be placed thereon. H, Fig. 1, is the bottom or lifting ring; this has slot holes cast in at the outer edge, as at B, Fig. 2, as also have the other two binders, I and J, Fig. 1, for the slag-bars E, Fig. 1, to be placed in after the mould has been dried to ensure further stability of the mould and allow the mould to be poured above the floor level. This obviates the necessity of digging a pit and ramming the mould up in it, and also digging the mould and casting out afterwards. This is certainly one advance made in the foundry industry.



The bottom of the mould is easily struck by means of a board forming the bottom, the step, and the joint. The middle part of the mould is struck up off the bottom. After all the brickwork is built and a daubing of dungy loam smeared on to it, a facing of hairy loam is worked up by the strickle board. This loam is always a little more wet, so as to take the shape of the strickle board more readily than the dungy loam. This facing of hairy loam is used exactly as facing sand is used in green sand moulding, and gives a very much better and smoother surface to the casting than dungy loam will.

The top part of the mould is struck up separately upon a strong top plate L, Fig. 1. The core or centre of the mould is struck up in halves by means of two templates placed upon a flat bed of sand previously struck, and level; each half has core irons, A, Fig. 2, so arranged as to be readily bolted together and tied by cross-bars.

There were 10 runners $\frac{3}{4}$ in. × $\frac{3}{4}$ in. at the top of the body of the casting F, Fig. 1, and only one riser, G. Fig. 1. Much more care was taken in the bygone days to finish a loam mould than is taken to-day. When the mould was dried and brought out of the stove, the loam moulder would commence to finish the mould by rubbing the glaze from the face of the mould, and then would burn off all the projecting superfluous particles of hair, then wet the face with water, so that it would the more readily take the black wash of which two coats were applied. The blacking consisted of a mixture of two parts charcoal and one part carbon blacking thoroughly mixed and allowed to stand so for *one* week before using. When this was brushed or painted on the mould it was sleeked as well, thus securely fixing the blacking on the face of the mould. Care was always taken to dip the sleeking tools into water frequently, so that the blacking should not stick to the tools. This method would give an exceedingly fine surface to the casting, and, generally speaking, the better the surface the better and sounder the casting throughout.

It is to be regretted that this system is not used more, so that moulds can be finished better; it is very distressing to witness a large casting being fettled by four men with pneumatic chippers endeavouring to get the sand off, when by the proper mixing and application of the blacking it could be avoided. Some foundries allow the men to mix the blacking as they like, just taking a shovelful and dashing it in a pail of water, stirring it for a few minutes, then applying it to the mould or cores. How can good, clean castings be expected by such slovenly methods? It is feared that modern methods and mass production tend to obliterate some of the operations in moulding which destroy individual craftsmanship.

American Blast Furnaces.—At the peak of war-time pig-iron output in August, 1918, blast furnaces in the United States totalled 438, of which 371 were active. In the ten years since then, 95 units have been abandoned, reducing the total to 343. During this period 77 merchant stacks were dismantled and only two were built, the net loss being 75. Of the non-merchant of steelworks furnaces, 38 were dismantled and 18 built, the net reduction for this class being 20. Conditions in the market have made it impossible for the small high-cost units to compete with large low-cost units. The 18 new steelworks stacks probably offset the capacity of the 38 abandoned stacks. Unquestionably during the next two or three years the mortality list will grow still larger, for the country's declining need for strictly merchant iron is slowly throttling the merchant-iron industry. *Iron Trade Review.*

Notes on Patternshop Management.—I.

By Ben Shaw.

The Patternshop's Relative Importance in an Engineering Works.

In a series of articles dealing with patternshop organisation and management it may be advisable to consider at some length the position of the patternshop in engineering works and its relations with other departments. Its position is unique in that it is usually regarded—it probably shares the unenviable distinction with the foundry—of being a non-producing department. The patternshop does not manufacture a finished article, and short-sighted works' managers sometimes regard money spent in new patternshop equipment as money wasted; at any rate, it is undoubtedly the case in many works that while machine and fitting shops are kept thoroughly up-to-date the patternshop machinery is obsolete. In recent years this has not been so marked, however, and on the efficiency of the patternshop, to a very large extent, the efficiency of all other departments in an engineering works depend.

Casting production is the work of both patternshop and foundry, but whereas the foundry is often severely criticised, the patternshop, let it be admitted, often escapes censure. We are told that the foundry industry is not progressive, that methods and machines are obsolete, and, in fact, that it is very largely responsible for the state of stagnation into which the engineering industry seems to have fallen. This is quite unjust, but it is as well to face the fact that many people so regard British foundries. The interesting thing is that, while both the quality and the price of castings are influenced very largely by patternshop practice, the patternshop escapes from criticism; but it is well to remember that it is not always the patternshop management's fault that its practice is not as good as it might be. A foreman patternmaker is not always given a free hand to make patterns that satisfy him.

American Practice.

It is sometimes said by British foundrymen, after a visit to the United States, that they were greatly impressed with the difference in quality of the patterns supplied to American foundries as compared with those supplied to British foundries, and it must be admitted that, in our keenness for cheap production, engineers have fallen into the habit of regarding patterns as a necessary nuisance. Quite often is the expression used in the patternshop that it is not a pattern that is wanted but a casting, the implication being that only the minimum of pattern work should be done and the result is that quite often the moulder has to produce a casting under great difficulties, and at the expenditure of much more time than ought to be necessary.

The methods used to-day are exactly the same as those used thirty years ago, and in this respect the patternshop must always be different from the foundry, to which there is no end to progress. The point is, however, that whereas thirty years ago some discrimination was used as to when skeletons could be adopted economically, the practice has grown of adopting the skeleton method of construction almost without discrimination in order to lower pattern-construction costs. The result of this has been that where a shilling is saved in the patternshop, a pound may be wasted in the foundry. It is sometimes said that a moulder could make a casting from a kitchen chair; and while this is true, it would be a very expensive casting indeed, and, after all, economical casting production can only be obtained by proper co-operation of patternshop and foundry, and a modification of the practice of the former to suit the latter. It cannot be denied that the average pattern of thirty years ago was much better, from a moulder's point of view, than that made to-day. It may be that the introduction and development of the moulding machine has influenced patternshop methods in this way that there is a sharp dividing line drawn now between repetition work and the other kind.

Marine Engineering Practice.

In motor-car shops, let it be said, the patterns made are of the very best class, but in marine shops they are certainly not so. In fairness, however, it is not quite right to generalise, and there is certainly some very craftsmanlike work turned out for heavy machine castings. The marine patternmaker who knows his job is a craftsman to his finger tips, but there is, in some shops, too great a tendency to make patterns without regard to moulding difficulties. Sometimes, when it would be more profitable to make a block pattern and core box, a flimsy skeleton pattern is made which involves a considerable number of drawbacks, and which, indeed, causes the moulder to exert all his ingenuity in getting a casting.

The patternshop occupies a different position—has a varying degree of importance, as it were—in different kinds of work. In a ship-repair shop, for instance, it is undoubtedly the most important department; it is the "key" department on which quick production depends. When a vessel is docked for repairs or reconditioning she must be again ready for sea at the earliest minute possible. The draughtsman's work must be reduced to a minimum. New valves, new pipe connections, and various deck and engine-room fittings will be required. Instead of a draughtsman visiting the ship and making sketches from which finished drawings will be made, the patternmakers are sent down. They make some rough sketches or a few dimensions, go back to the shop, obtain some template wood, and again visit the ship. The necessary templates are made, and patterns made from these. Alternatively, from a few dimensions the patternmaker sets out the work on a shop drawingboard, calculating thicknesses of metal, flanges, etc., required, and proceeds to make the necessary patterns. He works with the knowledge that foundry, machine and fitting shops depend on him. The foreman patternmaker, therefore, has to turn out patterns as quickly as possible, but he has to bear in mind that quick foundry production of castings is very important, and also that the work of machine and fitting shops has to be reduced as much as possible, and that there must be no difficulties when the casting goes to the ship to be erected in position.

In the ship-repair patternshop, it is a very common practice to make patterns from old castings. Here again the foreman patternmakers' skill as a designer is of importance. The casting has probably failed in service because of some defect of design, and additions, strengthening ribs, may have to be incorporated. It can be truly said that the success of a ship-repair yard depends very largely on the patternshop, yet it is very seldom that it is equipped with good machinery. This may be because in many shops only two or three men are employed, and the patterns are not finished as for repetition work. The foreman in a ship-repair patternshop usually executes the most difficult work himself. In even a small ship-repair shop there ought to be plenty of floor space, it should be well lighted, good-quality timber should be used, although most of the work done is of the on-off kind, because patterns can be made more quickly from good timber, and there ought to be band and circular saws, a planing machine and a trimmer. The foreman of such a shop requires to have much initiative.

Foremen Recruited from Drawing Office.

In a shipbuilding yard speed conditions are not quite as exacting as in a repair yard. It is more profitable to make better patterns. The foreman patternmaker depends to a very great extent on the drawing office blue prints, although if he knows his job thoroughly, be will frequently, in consultation with the foundry manager or the heads of machine and fitting shops, modify a design to simplify moulding or machining operations. Before the construction of a pattern is started the chief draughtsman may consult the foreman patternmaker. All things considered it is not very surprising that firms will sometimes give the position of foreman patternmaker to a draughtsman. One of the most capable foreman patternmakers the writer has known was a draughtsman, who had originally served an apprenticeship in the patternshop.

In many shipyards there are two patternshops—an engine shop and a yard shop. Even when there is only one shop it is usually divided into two sections. The methods of the yard shop approximate rather closely to those of the repair shop; the work consists largely of deck fittings and equipment, including hawser pipes. Accuracy is not as important in a yard shop as in an engine shop. The foreman of a yard shop has to co-operate closely with the heads of all the other departments. It is in the yard patternshop that all the big hull patterns are made, such as stern frames, propeller-shaft brackets and rudder frames.

Progress of Equipment.

The equipment of a modern shipyard patternshop is usually thoroughly modern, but it is interesting to compare the average modern patternshop with one of thirty years ago; even in large pattern shops thirty years ago the machinery comprised lathes, probably a circular and band saw, and that was all. In smaller shops of that time, apart from lathes, there was probably no other machine. To-day in a large patternshop the machine equipment may include two circular saws, one called a dimension saw, being suitable for both cross-cut and ripping work, and the other a much larger saw, being used solely, or almost solely, for ripping. There is also invariably a band saw, and in some cases two band saws. In small shops there is, in nearly all cases, a band saw, and only occasionally a circular saw.

It is remarkable that some of the worst equipped and managed patternshops are those of machine-tool makers. We knew of several patternshops of firms making punching and shearing machines and lathes a few years ago in which there was not a machine of any kind. One would expect that firms that urge the need for the installation of up-to-date machinery for efficiency in the metal-working shops would not fail to have their own shops, including the patternshop, properly equipped. In machine-tool shops, unless when orders are obtained for special machines, new patterns are not commonly made. The standard patterns are altered over and over again to suit special requirements. Skeleton patterns are not much used in machine-tool shops. One reason being that new one-off patterns are not common, and there are no valve or pipe patterns.

Locomotive and Petrol Engine Shops.

We have been considering shops where, accompanied by innumerable details, patterns for castings of twenty tons or more are made. Let us now consider the class of shop making petrol engines, and locomotive shops. Instead of twenty or thirty being employed on a pattern there are seldom more than three or four on each piece of work, and the majority of the men in the shop work single-handed. The work is of a repetition character. A very large proportion of the patterns are made for machine moulding, and accuracy is very essential. There are not as many moulding problems to be solved as in marine and machine-tool shops, and the drawing must not be departed from. The foreman in such a shop must check work with the greatest possible care. First cost in patternmaking is of less importance than quality and accuracy. Generally it is found that patternmakers who may be very satisfactory in a motor-car shop are unsuited to marine work, and, of course, *vice versa*. In such a shop it is not usually necessary to consider other than the actual patternmaking, as the drawings supplied are very complete. Motor-car and locomotive shops are usually well equipped with machinery.

At one time jobbing patternshops were invariably badly-equipped shops, run largely with boy labour, and turning out work of poor quality. There has been a considerable change in jobbing patternshops in the last twenty years. Many such shops turn out very fine work, and they labour under the disadvantage that they cannot consult drawing office, foundry or finishing shops.

Belgian Foundry Owners' Federation Formed.

Mr. Ropsy to be First President.

Of the greatest importance to British foundry owners is the news that Belgium has created a strong national foundry owners' federation, under the chairmanship of Mr. Paul Ropsy. Mr. Ropsy was the first President of the International Foundrymen's Committee. He is a born organiser, and his charming personality ensures that wherever he goes he forms fast friendships. He has travelled largely in both America and Europe. This new organisation now places Belgium in a similar position to France, Germany, Holland and Spain. The news comes just at a time when one of the principal British foundry owners' associations is passing through a crisis, and we hope that the manifesto, which we print below, will hearten this association to more intense efforts and help the non-federated foundries to consider their position in relation to the great basic industry of which they form a part.

Manifesto Sent to all Belgian Founders.

The manifesto referred to reads: :—

"Belgian foundrymen, at least most of them, have realised the necessity for an association for friendly collaboration in trade matters. In the midst of all the industrial and commercial arrangements which are being set up daily an isolated firm is constantly risking the disadvantage of finding himself in a more and more pronounced state of inferiority, and this risk, in the turmoil of an actual economic war, may become a vital one. Beware of isolation! In the foundry, as in every other sphere, and probably more than in most, this danger is serious. Many founders recognise it. Fears, threats and attacks have already been encountered.

"After a preparation, necessitating much energy, patience and perseverance, the Syndicat General des Fondeurs de Belgique (the Belgian Foundry Owners' Federation)—a non-profit-making association—was formed on July 18 at Brussels.

"The efforts of the promoters has been well justified, as 90 Belgian foundries have responded to the appeal, and have expressed a desire to be founders of the association. Amongst these 90 founders are manufacturers of steel, iron, malleable and non-ferrous castings, and include the largest concerns as well as medium-sized and the smallest. Some employ hundreds of workmen, others scarcely any. It is a magnificent result, and one on which both the promoters and the newly-formed federation can congratulate themselves. The diverse character of the joining firms proves that the movement for collaboration has found everywhere in the industry enthusiastic foundrymen anxious to support an employers' federation.

"Undoubtedly those hesitating will come forward in their turn, urged along either by example, industrial unity, or—necessity.

"Without hoping to set out at length the activities for the new association, it can be said that the programme will be modified or developed according to the wishes of the members, and according to circumstances and opportunities, but it can already be stated that the following will appear on the agenda:—Collection of data relative to the interests of the industry; diverse economic questions such as customs, regulations of taxation, production, improvement in the technique of production; standardisation; buying, selling, transport conditions; industrial insurance; trade organisations, conciliations, arbitrations, expert evidence, consular elections, etc.; commercial expansion, exhibitions; professional and trade education; scientific publications, schools, travelling scholarships, research work, etc. Before even having received the consideration of its future members, the federation had had already before it a very active programme, and this short *resumé* is sufficient to show how such an organisation will respond to the necessities of the many and varying demands.

"Belgian foundrymen can therefore congratulate themselves that in the interest of everybody, and especially their industry, this association has come into being, and extend their good wishes to those who lent their influence to the establishment of fraternal collaboration.

"The general meeting which followed the inaugural meeting, after congratulating the promoters on their initiative, unanimously elected the following as the first board of directors:—Messrs. Balaes (Brugeoise, Nicaise et Delcuve); Brasseur (Compagnie Generale des Aciers); Cognioul (brass founder); Edmond Denis (iron-founder, of Buysinghem); Simon Durant (phosphor-bronze founder, of Herstal); Fosseprez (Acieries de Mons); Hette (National Radiator); Joseph Legrand (engineers and founders, Brussels); Emile Levie (Ateliers de Construction de la Basse Sambre); Arthur Martin (Fonderies Nestor Martin); G. Patyn (des Ateliers van den Kerckhove); René Pierard (Fonderies Schippers et Podevyn); P. Ropsy (Société Belge Griffin); R. Sibille (Usines Montefiore); and Wery (Hauts Fourneaux et Fonderies de la Louvière).

"The directorate elected Mr. Paul Ropsy (managing director of the Société Belge Griffin, Merxem) as President, and as executive officers Messrs. Maurice Balaes and Simon Durant. The director and secretary is Mr. A. Stievanard, whose office is (provisionally) at 11, rue de Congrès, Brussels.

"A number of founders who were unable to be present at the meeting, when apologising, sent congratulatory letters and telegrams. These good wishes will be tested in the future. As to the founders of the federation, they state that they only wish to enrol those who carry out their business on the best lines. A powerful federation, flourishing industries, a union for all which will benefit the individual. Also Belgian founders are convinced that amongst those who are to-day remaining outside and isolated, and who are not complete egoists—that is, those who remain unenrolled through forgetfulness or error of judgment—will come along sooner or later to the federation, which will print beneath its title as its motto the modern maxim, *All for one, and one for all.*"

The Problem of the "Big" Customer.

By W. J. Hiscox.

It is very nice for a small foundry to be successful in obtaining large and regular orders from a big industrial works, even though in the main these orders have to be accepted at cut prices. It makes matters so easy, and there is not that necessity for getting about after orders as there would be were the foundry entirely dependent upon the small requirements of a number of individual customers. The one customer perhaps provides sufficient orders to keep at least one half of the foundry fully employed, so it is not a difficult matter to secure sufficient orders from smaller customers to provide work for the other half.

But it has to be remembered that the big customer is master of the situation, and can insist upon his own interests receiving the first consideration. Whatever he wants he must have, and if this must be at the expense of the claims of other customers—well, it cannot be helped. If certain of the other customers resent this, and place their business elsewhere, their orders are, after all, but small ones, and the loss will not prove serious, but were the big customer to withdraw his orders, that would be a calamity, and this must be avoided at all costs.

A small foundry loses its independence and freedom of action when it comes under the domination of a powerful customer, and although there are obvious compensations, the position brings about a feeling of insecurity. "You are all right, so long as you do as you are told," says the customer, but it is not always pleasant to do just as one is told. Yet at the merest sign of revolt the warning flashes forth, "Be careful, or you may lose all."

It is possible, however, to do substantial business with a big customer without allowing him to dominate the proceedings, if a definite and resolute line of policy is followed. Many small foundries are so anxious to secure the orders of the big customer that they will submit to any conditions he may care to impose, and it is not long before this one customer is running the foundry. Naturally, he has no interest in the claims of other customers, and he does not consider them.

The way to deal with the big customer is to treat him as a customer, and not as a patron. He places his orders with the foundry because he wants what it can supply, and he believes it will pay him better to place his orders there than elsewhere. He is not actuated by a desire to do the foundry a good turn, but to do himself one; if he could do better elsewhere, he would not hesitate to place his orders elsewhere. Thus, there being no obligation on either side (save only the obligation of fair dealing which should characterise any business transaction) the foundry is not called upon to accept the domination of any customer, even though his orders exceed those of all the other customers. The requirements of the big customer must of course be met, and as these are somewhat extensive, it is possible that special facilities must be provided, but no matter what steps are taken, they must be at the instance of the foundry and not of the customer, and they must be devised to cater for the interests, not only of the big customer, but of all customers.

There are some small foundries who go to considerable expense in enlarging the shops and putting down new plant to meet the requirements of the big customer, only to find that after a time these requirements tend to diminish. Then it is that the orders of smaller customers are sought after, but they are not easily found, as these customers look askance at a foundry which, after being almost exclusively concerned with one big customer for a long time, begins to look elsewhere for orders. Extensions to buildings and plant should not be embarked upon until all the factors have been fully considered, including the possibility of a falling-off in the volume of business with the big customer, and the chances of making good any deficiency with additional orders from other sources.

Policy to be Followed.

The line of policy to be followed, if independence and security are to be maintained, is to get as many customers as possible on the books. If some of these develop into big customers, so much the better. But all customers, whether big or little, must receive the same consideration, for the orders of one are just as essential to the foundry as the orders of another. If it becomes necessary to extend, owing to the volume of business being done, then of course extensions must be carried out, but if the suggestion for extension emanates from a big customer, or if extensions are necessary primarily as a result of the increased business being done with a big customer, the continuity of this business should be safeguarded for such a period as will justify the expense incurred.

Some foundries may consider that, without the orders from the big customer, they would possess but a small jobbing shop, whereas, as a result of these orders, they are in possession of a building of quite respectable dimensions. But they have to remember the bigger the undertaking, the bigger are the responsibilities. It is right to utilise the orders of the big customer for the purposes of development, but it is unwise to devote the development solely to the interests of the big customer.

Many small foundries think that, once they have secured the business of the big customer, their future is assured, and nothing remains to be done but to satisfy the requirements of this customer. This is much easier than catering for the requirements of the many, and so they stake everything upon one throw. But experience shows that the time will come when the tranquil period will come to an end, either because the demands of the customer become impracticable, or because he decides he can do better elsewhere. It may be contended that if the foundry devotes itself almost exclusively to the interests of the big customer the latter contingency will not arise, but unless there are unremitting efforts to guard against competition it will. The big customer deals with the foundry just so long as he cannot do better elsewhere, and when he finds that he can do better, away goes his business. It is well, therefore, for the small foundry to treat the orders of the smaller customers with the same respect as the orders of the big customer, so that, if anything goes wrong, the loss will not be irreparable.

Cast Iron for Locomotive Cylinders.

By Our Metallurgical Correspondent.

As in other branches of engine design, the modern developments in locomotive design have necessitated very careful study and consideration of the character of the materials used in their construction. The cast iron of which the locomotive cylinder is constructed has been the subject of equally as careful scrutiny as the other materials which go to build up the locomotive. As a casting the locomotive cylinder has been frequently instanced as one of the most difficult that foundrymen are called upon to produce, and in spite of all the complex patterns submitted to modern foundries there can be no doubt that this is still true. It is certainly true that the progress and development in the design of these castings has not had the tendency to diminish the responsibility of those engaged upon their production.

Locomotive cylinders fall into the classification of the monobloc cylinder construction, and as such may be regarded as the giants of the type. The cylinder proper, the valve chest, inlet and exhaust passages, steamways, flanges and pedestals are all embodied in the single casting, and the twin cylinder forms of construction commonly adopted more than rival in intricacy the more familiar example of monobloc cylinder construction, *viz.*, the automobile cylinder. Locomotive cylinders vary in size and weight from quite small cylinders weighing about one ton to large castings of upwards of five tons in weight, and are required to conform to equally as high standards of excellence as their smaller brethren in the monobloc cylinder family. In view of their much greater individual weights the incidence of waster castings on the production costs is of a vastly greater order in the case of locomotive cylinders than in small petrol engine cylinders and the successful production of the former is a testimony to the high order of care and skill on the part of the foundrymen and metallurgists engaged in their production.

Character of Metal of Vital Importance.

From a metallurgical point of view the character of the material is of vital importance in at least two directions. Firstly, the character of the material in its influence on the successful production of the castings, and, secondly, in its influence on the successful behaviour of the castings in service constitute the two points of view from which the metallurgist is required to study this material. It may be said in connection with this latter aspect that the conditions of service which exist in the modern locomotive cylinder are the most arduous and exacting that cast iron is called upon to withstand in engine cylinder practice. This statement is made with full knowledge of the conditions of service which exists in large internal combustion engine cylinders which of late years have been so much to the fore that we have tended to overlook the modern locomotive cylinder in our considerations.

In an entirely general sense one of the most important demands of the modern engineer of cast-iron metallurgy is the maintenance of his requirements with the strictest possible uniformity, consistency and exactitude. The maintenance of strict uniformity and quality of cast iron is no small problem, but nevertheless it is of utmost importance, and in many respects it is even possible, to sacrifice quality in some degree to obtain this uniformity and consistency. The demand for this uniformity of quality and character is to be ascribed partially to the modern methods of quantity production, which obviously in all its aspects calls for uniformity of quality, properties and behaviour in handling, working and production on the part of the raw material. The more accurate workmanship in the assembly of engineering structures, the more accurate and quantitative understanding of the principles of design, the accumulated experience in design and production has steadily eliminated many of the sources of trouble and inefficiency, that the engineer can now point out with certainty to the lack of uniformity in his materials as the only weak link in his chain of calculations. Herein is another partial cause of the insistent demand for uniformity, and it is obvious that such uniformity is necessary to enable true comparisons to be made of the behaviour of material in service. This is particularly true of cast iron in general and of cast iron locomotive cylinders in particular.

Variations Disclosed.

The most vital requirement of the cast iron for locomotive cylinders in service is, of course, resistance to wear, and this requirement under the modern conditions of superheated steam with its attendant difficulties in lubrication is by no means the least of the metallurgical problems in connection with such castings. The metallurgical problem is complicated by the very complexity of the locomotive cylinder as a casting, and in all considerations of the most suitable composition it is impossible to neglect the influence of this on the "castability" of the metal and the production of sound and satisfactory castings. From time to time the composition of metal used for locomotive cylinders has been revealed, and a summary of some of the more important examples is given in Table I.

Table I.—*Compositions Used by Various Authorities for Locomotive Cylinders.*

Example.	T.C.	Gr.	C.C.	Si.	Mn.	S.	P.	Reference.
G.E.R., Stratford ..	3.18	2.57	0.61	2.02	0.50	0.125	0.77	Gibbs, F.T.J., Oct. 26/22
M.R., Derby ..	3.5	2.7	0.8	1.2	0.80	0.08	0.45	Pemberton, B.F.A., 1909/10
America	—	—	—	1.2 to 1.5	0.80 to 1.0	0.10	0.30 to 0.50	Porter, A.F.A., recomd.
Paris-Orleans ..	3.0	—	—	1.5	0.65	0.10	0.20	Audo., J.I.B.F., 1926/27.
German	3.2 to 3.6	—	—	1.0 to 1.4	0.6 to 0.9	0.12	0.70 to 0.90	Hutte (French translation)

In conjunction with the figures given in Table I, the analysis referred to as long ago as 1910 in the correspondence columns of The Foundry Trade Journal is of particular interest. This analysis recorded below is stated to be that of a locomotive cylinder which had given remarkably long service, having been in operation for a period of 25 years, with only one "rebore" during this long period. The recorded analysis is as follows:—Total carbon, 3.100; graphite, 1.885; combined carbon, 1.215; silicon, 1.633; manganese, 0.360; sulphur, 0.219; phosphorus, 0.905 per cent. One of the most important features of these analyses is that as long ago as 1910 the comparatively modern demand for low total carbon contents found support in daily locomotive cylinder practice, and the compositions as a whole are little at variance with the practice which would be recommended to-day. In the latter case it may be considered that the sulphur and phosphorus contents are a little on the high side, whilst the manganese content a little on the low side, and this reminds us that it has yet to be proved that such a composition is detrimental to the properties, and many locomotive engineers might be prepared to assert that the higher phosphorus content would increase the "castability" of the metal and might conceivably increase the resistance to wear. Further, they might assert that the condition of low manganese contents and high sulphur contents is the only reliable method of regularly obtaining high combined carbon contents, which are rightly deemed necessary in castings required to withstand wear under the temperature conditions which exist in locomotive cylinder practice.

The locomotive cylinder casting is one of those castings in which extreme importance has been attached to the character of the pig iron entering into the cupola mixture. It has been pointed out frequently by the older generation of foundrymen that the cold blast pig-irons are a *sine qua non* in the successful production of locomotive cylinders. There is no doubt that the ordinary grades of hot blast pig-iron alone are not suitable for this class of work, and will not give the highest possible degree of properties desired. On the other hand, it cannot be denied that in many of the older mixtures for the production of locomotive cylinders the advantages expected to accrue from the cold-blast iron used were partially or wholly ruined, from the point of view of the highest standard of locomotive practice, by the addition of hematite irons with their normally high total carbon contents. In actual practice the idea of the indispensability of cold blast irons (*e.g.*, Audo J.I.B.F., 1926/27) has been completely exploded, and we are probably correct in saying that a large and certainly an increasing proportion of British locomotive cylinders are made from mixtures containing refined iron or iron made under "slow smelting" conditions. That this is a distinctly progressive step cannot be doubted, and this practice takes care of the very vital point which has hitherto lain outside the control of the foundryman; that is, the variability of furnace pig-irons. Furnace pig-irons (even cold blast) may vary not only from cast to cast, but from pig to pig, and this is a matter which is undoubtedly the ultimate cause of many failures both in the foundry and under service conditions. If the highest standards are to be maintained and improved upon definite uniformity in the pig-iron is necessary, and it is this fact more than any other which is responsible for the growing popularity of refined irons or the like.

Catalogues Received.

Sand Mixers.—The Record Corporation, Limited, of Tutbury, Burton-on-Trent, have prepared a leaflet illustrating and describing the Hall's Improved Invincible sand mixer, which is now available in three sizes, 20, 24 and 36 in., which respectively deal with 1½, 3 and 6 tons of sand per hour. The machine is of the type which operates by means of rows of bars revolving in opposite directions.

Nickel and its Alloys.—The Research and Development Department of the Mond Nickel Company, Limited, of Victoria Station House, London, S.W.1, have sent us a loose leaf binder for the reception of their technical publications. It is so beautifully made and well thought out that one experiences, on receipt, a pleasure usually associated with a personal gift. The binder is divided so as to file the information under the following captions: General, Nickel, Electro Deposition, Alloys with Copper, Alloys with Chromium, Alloys with Iron (practically carbon-free), Steels, Sundry Alloys. A curious impression was left on our mind by the absence of any specified place for "alloys with a cast-iron base." Does the Mond Nickel Company deem it of insufficient commercial importance? We may be wrong, but we consider that the experimental work so far published sufficiently encouraging to warrant further work. Moreover, alloys of the "Nomag" have been a commercial proposition for some years now, and absorb in their composition more nickel than some steels. We suggest that it would be useful if we could file in the binder in the near future a table of nickeliferous alloys with their chief properties. We remember making in early war days many tons of a 25 per cent. nickel steel containing (if our memory serves us correctly) 1.5 per cent. carbon and 2 per cent. chromium for machine gun loading strips. This most interesting steel was the nearest approach to metallic leather we have ever encountered. Under certain conditions, if one bent it, it "stayed put," to use an Americanism. Surely a steel of this kind is capable of some peace-time development. Moreover, there may be others, and such a collection placed before the engineer (and we presume that this binder is primarily intended for the engineer) would arouse his interest of the industrial potentialities of nickel alloys.

Theory or Practice in the Grey Iron Foundry.

Mr. John Shaw, Britain's most enthusiastic foundryman, has, in the form of a Paper bearing the above caption, placed before the industry a problem of vital importance. In order to transform the Paper from an academic contribution to a dynamic force in foundry circles, Mr. Shaw has collaborated with us in collecting the views of many prominent people in the industry, and their views are set out below.

Mr. J. G. PEARCE, B.Sc., Director of the British Cast Iron Research Association.

The questions raised by Mr. Shaw in his Paper are of great importance and of particular interest to the British Cast Iron Research Association. He asks, in effect, whether it is not better to study cast iron by what might be described as the analytic method—that is, by starting with a base that is undoubtedly cast iron, and making suitable variations on that—rather than by what might be described as a synthetic method of taking a pure iron-carbon base and building up by adding appropriate elements. It is quite true that in the latter case the ultimate material does not behave as ordinary cast iron behaves, so that the results are distrusted accordingly. An effective study of the subject by the latter method would also occupy an army of research workers for several years, and the cost would be greater than the industry, in its present state, can bear. The study would be complicated by effects, some of which Mr. Shaw has mentioned, such as the influence of gases, pouring temperature, etc. The application of the results would be open to doubt, due to the fact that in cast-iron practice the metal never reaches a state of equilibrium. On the whole, therefore, we sympathise with Mr. Shaw's suggestion that the material worked on should be a cast iron, and for some time past the Association has carried out experiments on a base which, while not of the same analysis as that given by Mr. Shaw, has been made in the open-hearth furnace, and is low in total carbon, silicon, manganese, phosphorus and sulphur. Even this method, however, presents its difficulties. It would not seriously be possible to study the influence of manganese and sulphur on a base containing manganese 0.5 and sulphur 0.03 per cent. In order to deal with this question it is necessary to start with a manganese-free, sulphur-free base, and to ascertain the effects of each before they are tried in combination. It is thought that the Cast Iron Research Association can do its most effective work on cast iron by utilising a cast iron base of the kind suggested, melted in furnaces of the kind used in the trade, the crucible and the cupola. We see no reason why national and University laboratories should not study along the synthetic line, as work such as that of Dr. Hanson, while, as he himself admits, not directly applicable to grey iron practice, is immensely valuable in suggesting new ways of looking at cast iron and its behaviour, and these in turn influence the more practical work. An interesting illustration has recently been afforded of the value of the two methods by our recent work on nickel in cast iron, which was first studied in the University of Birmingham on a laboratory scale by making synthetic mixtures, and as information was obtained this was followed by practical full-scale melts in crucible and cupola furnace, with very useful results.

Too much importance should, perhaps, not be attached to isolated figures of total carbon and silicon quoted by various investigators from bars of similar size. In many cases there were special features about the work which would explain some of the differences found: the rest of which could probably be explained by reference to pouring temperature, moulding conditions, etc. As Mr. Shaw is aware, the variations he quotes from experimental records are not found in ordinary practice.

It would be regrettable if the view expressed by Mr. Shaw regarding German advances led anybody to think that they were not dependent on metallurgical knowledge and training. While they are extremely practical, and arose out of practical experience, they come from men who have profited by the intense metallurgical training available in Germany.

Another point of great importance which is being met constantly in practice is found in experimental work; that is the heterogeneity of mixtures which are often presumed to be homogeneous. Rich and lean ferro alloys added to a given base to produce the same amount of added element do not give the same results.

The foundry industry is under a very great debt of gratitude to Mr. Shaw for his pertinacity in pursuing the results of investigations and pointing out the discrepancies between them. In this way he succeeds in focussing the attention of metallurgists upon the spots where attention is most needed, and it is highly probable that some of the more pressing problems he mentions will have light thrown on them in the near future.

Mr. F. J. COOK, M.I.Mech.E., Past-President of the Institute of British Foundrymen.

I have studied the effects of this element on high duty irons very closely for at least 25 years, and my experience is that where the silicon and total carbon exist in the ratio given in my formula for high tensile irons, a phosphorus content up to and including 1 per cent. has no detrimental effect upon *any of the physical properties* of the metal. In physical properties I include tensile, modulus of rupture, impact, dilatometric phenomenon, etc., but where the condition as to ratio of Si and total C do not exist then phosphorus has a very marked effect. I have never failed to search for any evidence of bad effects in my conditions, but have never met a single case.

On the other hand, however, wherever you find quoted bad examples of the influence of phosphorus you will invariably find the ratio of C and Si to blame.

In my ratio of C and Si I have always aimed at 3 per cent. total carbon and a corresponding 1.2 per cent. of Si.

In my experiments with cylinder iron I, a long time ago, found that 0.5 per cent. phosphorus showed a decided tendency to segregation, porosity, and a tendency to cracking, but when this element was raised to 0.7 to 1 per cent. these bad effects were eliminated. That 0.5 per cent. is a deleterious quantity has since been confirmed by the metallurgists of two of the best motor cylinder manufacturers of this country, who each independently of the other have experienced the same troubles. With this in mind, in connection with a research now going on, I suggested that with cupola-melted irons the range of phosphorus—which goes from very low to very high—should contain one of 0.5 per cent., and the results obtained showed that this one gave results *much out of step* to those obtained with other quantities present, although with refined irons the results were not so pronounced.

I therefore always suggest that this 0.5 per cent. range should be avoided, recommending either 0.4 per cent. and below or 0.6 per cent. and up to 1 per cent., leaving each one to make his choice.

That phosphorus reduces the total carbon has been shown by many workers, particularly Stead: but attention has not, as far as I am aware, been called to the fact that phosphorus by virtue of its taking up carbon leaves more ferrite in the matrix.

Take my cylinder metal, *i.e.*, total carbon, 3 per cent.; C.C., 0.8 per cent.; G.C., 2.2 per cent.; Si, 1.2 per cent.; Mn, 0.4 per cent.; S, 0.12 per cent.; and take out the constitutional analysis with 0.4 and 1 per cent. phosphorus, and you get the following result:—

	Phos. 1 per cent.	0.4 per cent.
Graphite	2.2 per cent.	2.2 per cent.
MnS	0.33 per cent.	0.33 per cent.
Phosphide eutectic ternary	14.5 per cent.	5.8 per cent.
Pearlite	55.0 per cent.	73.5 per cent.
Ferrite	27.97 per cent.	18.17 per cent.

Thus the hard phosphide in the network formation holds up against wear, whilst the extra ferrite butters down and takes up quickly the high polish necessary to all good wearing conditions.

Phosphorus, like nickel, I find refines the graphite, also refines the pearlite, tending also to make it granular instead of striated.

That phosphorus is not detrimental to high physical results I showed in my American Paper; since then the following results have been obtained by an entirely unbiased gentleman, who selected haphazard a few test bars which were in stock, and which he found gave the following results. The bars were cast 1¼ in. diameter and turned down to ½ sq. in. area for tensile test.

It has been considered by Fletcher that dendritic structure would always give poor physical results.

Tensile test—Tons per sq. in.	16.5	17.0	19.2	19.7	20.1	21.2*
Transverse test—1 in. sq., 12 in., centres ..	40.5	29.5	36.5	32.75	37.5	—
Modulus of rupture—Tons	36.45	26.55	32.85	29.45	33.75	33
Impact—.48 ft.-lbs.	531	506	306	614	627	656

* The last example was sent later and was not one of the bars he had taken away. Each bar is from a different day's cast.

It is interesting that the structure of the last bar quoted in the table above was as dendritic as possible, yet the results are exceptionally high in every test, and shows that a dendritic structure in this case has not been harmful.

Mr. W. B. PARKER, F.I.C., Chief Chemist to the British Thomson-Houston Company, Limited.

The Synthetic Method of Research.

The opening remarks mainly give me the impression that you are somewhat adverse to what Mr. Shaw has termed the "Synthetic" method of ascertaining the action of an element—such as silicon or manganese—upon the structural constitution, also the mechanical, chemical and physical properties or practical behaviour of any cast iron.

But, unfortunately for your readers, Mr. Shaw does not define the scale upon which the synthetic experiments to attain this object are performed, and this leaves one in doubt as to whether he would or would not accept as "practically satisfactory," in a foundry sense, the results of synthetic methods conducted upon, say, 1-cwt. or 4-cwt. lots, or even still larger quantities, per melt.

If these so-called synthetic methods are attempted upon *small* weights of material—say, anything under 1-cwt. lots of each mixture—I am very much in agreement with you, since there is undoubtedly a point in the "quantity" scale of the melting work where certain of the always occurring variables have an exaggerated influence, *i.e.*, their effect upon certain properties are exaggerated in comparison with their effect when larger masses are prepared, *i.e.*, melted all at the same time.

For this reason I am always sceptical of the working value or practical foundry value of work done at the national institutions both at home and abroad which employ less than 1-cwt. melts of each mixture prepared.

For instance, the recent interesting Paper by Everest, Turner and Hanson, which is based upon 24-lb. melts of each mixture, is, to my mind, unsatisfactory if the results are claimed to represent in any quantitative or positive manner "cast iron." *i.e.*, as the actual foundry trade understands the matter. It is, however, necessary to notice in this particular Paper that the authors definitely disclaim such a direct application. It is just possible that this repudiation of this claim is due to the fact that the chief author, Dr. Everest, was for several years under me as an apprentice and he learnt by contact with our foundry the effect of quantity.

The above critical attitude, of course, holds still more severely when one contemplates some of the N.P.L. work which has been done on quantities of 4 to 8 ounces.

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Much of the Japanese and Continental work is of this very small scale type, and I think Mr. Shaw is doing a good service by calling attention to the doubtful value of such work to the grey-iron foundry.

On the other hand, if the synthetic method of investigation is conducted by using melts of 1 cwt. (112 lbs.) or more at a time (and I know privately many such investigations), I am willing to accept the results as being on a sufficiently large scale to give very fair practical results upon which a foundry manager could base his still larger every-day production without fear of loss or irregular results.

Melts of 1 cwt. permit of making several large sample bars from 14 in. dia. upwards, and moulding them in a strictly similar manner to those employed in a large portion of ordinary foundry work, *i.e.*, with ample "heads" and other practical features.

To such a bar the objection with regard to the ratio of superficial area to cubic content is not applicable, for instance, the 1¼ in. dia. bar of 15 in. length will weigh approximately 8 lbs.

It will have a cubic content of 31 cub. ins., and the superficial area, including ends, will have the ratio to content of 80.6 to 31.0, and the circumference is in the ratio of 5.1 to 2.07 sq. ins. cross-sectional area. This type of ratio holds good for a considerable quantity of grey iron foundry work.

With reference to the use of synthetic methods in steels it will be found that a very considerable portion of the synthetic investigational work upon plain carbon steel, alloyed steel and steel alloys which has been conducted in France, Germany, and Great Britain has been performed on individual melts of the order of 1 cwt., and, so far as the results obtained have been applied, the information so got has been sufficiently practical to enable the steelmakers to go straight ahead and make up, say, 2- to 5-ton lots of the material *and obtain first class practical results* and follow up immediately with 50-ton melts.

Influence of Mass.

This fact, I think, fully vindicates the use of the synthetic method for metallurgical investigation—but, as I say, its practical value is entirely dependent upon employing a sufficient quantity of melt to swamp those effects which tend to have exaggerated influence when small quantities are melted, and yet, on the other hand, allow those laws which are of paramount importance and influence in ordinary foundry work to get into action and exert their influence upon the test results.

Further, even if such an investigation has in the first instance been conducted upon a series of alloyed steels—for example, say, "Mn + Si" steels, the results obtained *can be applied directly and successfully to cast iron*, provided ordinary commonsense metallurgical forethought and foresight are employed in the process of application. *There is no doubt about this*, because I have tried it and proved it personally.

It is worth noting that a considerable amount of this synthetic research work on steels concerns material containing over 1 per cent. carbon and silicons over 1 per cent. Such results are getting near to our low total-carbon cast irons.

Here, then, is opened up a wider source of existing synthetic information, primarily obtained for steel making, but which is extremely useful to grey cast-iron foundrymen, provided they have had a real metallurgical training and have at hand the help of a good laboratory.

It is in this sense that I am a strong advocate for the large-scale synthetic method of investigation in cast iron, and the application of the indications obtained in steel to the planning of such work in cast iron.

Manganese Hardens Cast Iron.

I do not quite agree with Mr. Shaw's attitude upon the question of the action of manganese on grey cast iron. If one starts with a grey pig-iron containing 0.8 per cent. silicon, but which contains not over 0.05 per cent. of sulphur and not over 0.25 per cent. manganese (there are such pig-irons produced by the ton per blast furnaces), and then keeping the silicon, total carbon, phosphorus and sulphur steady, one increases the manganese alone to quantities such as the following:—0.5 per cent. up to 3 per cent. in 0.25 per cent. increments, and after this 3.5, 4, 5, and 7 per cent., the results of electrical and mechanical tests (tension, compression, shear, transverse and hardness), also chemical and microscopic tests upon such a series of melts will show:—(1) A steady increase in strength; (2) a steadily increasing stability of the carbide (in the case of mixtures low in silicon, the carbide is the double carbide of iron and manganese), thus proving the manganese increases the solubility of the carbon in iron; and (3) a fairly steady increase in the combined carbon percentage which is equivalent to a general increase of hardness of the metal. Hence manganese *does* harden grey cast iron.

Procedure for Research.

Of course, to get a full knowledge of the combined action of manganese and silicon it is necessary to make several such series of alloys. Personally, I would say at least 14 series with varying silicon contents, but in each series the silicon to be constant at one or other of the specified percentages below. If I were scheming such a series of tests I should employ the following percentages of silicon:—0.5, 1.0, 1.25 per cent., and continue the 0.25 per cent. increments up to 4 per cent. This means 210 melts, each of at least 1 cwt. quantity. To make 210 melts is obviously a big task. The amount of practical work is very considerable and the cost rather high. Also it demands a first-class leading metallurgist and a thoroughly well-organised and sufficient staff of investigators. If only two melts per day could be made or, say, 10 to 12 per week it would take about 20 weeks constant melting to get all the samples. Then as regards their testing it would be fairly certain that only one or two melts could be completely tested, and a proper consideration given to the results *per week*.

Suppose that two melts were dealt with completely and the records all written up, this means at least two years' constant work for a fairly large staff group, say, four experimenters and a senior assistant. In spite of the magnitude of the task thus outlined I consider it is urgently needed, and would repay itself, and that the results would be of permanent and practical value to the industry.

With further reference to manganese, the unsatisfactory points about the quoted Japanese work are that only five points are given and the silicon varies 0.25 per cent. in the series, also they do not start low enough down the silicon scale (it ought to have started with one-half the amount Hamasumi used).

It also ought to have included much higher silicons and the manganese ought to have gone up in much smaller and regular steps, for instance there is a step from 0.69 to 1.34 per cent. Mn. But in spite of very self-evident deficiencies and doubtfulness of the results the results emphasise the fact that manganese does:— (1) Retain the carbon in combined form, and (2) harden grey cast iron in two of the usual test methods of determination of "hardening" (even in the presence of 1.7 per cent. silicon).

It is therefore erroneous when the Japanese state that in grey cast iron, manganese up to 2 per cent. (in the presence of silicon) does not retain carbon in the combined form. Their own test values disprove this, although they are too scarce in numbers to be very convincing.

How Manganese Acts.

Personal experience and early experimental work have shown that: (1) When there is no sulphur present, the first 0.1 per cent. manganese acts in the same sense as in steel, namely as a de-oxidiser; (2) if there is over a trace of sulphur (for argument, say over 0.02 per cent. S) the first one or two tenths per cent. of manganese re-act with this sulphur and form MnS, the excess of Mn (if any) above this requirement then acts firstly as a de-oxidiser, and then the *final* excess has its own true action upon the bath of molten cast iron: (3) this "final" excess undoubtedly has a hardening effect on grey cast iron in that it retains and increases the percentage of combined carbon: and (4) the hardening effect is not as clearly shown in grey cast iron containing over 2 per cent. silicon owing to the very much greater influence of silicon, which influence is always antagonistic to hardening.

Now this statement indicates that prior to plotting the effect of manganese upon the carbon present the percentage of manganese actually added requires correcting by deduction of the percentages used up for items (1) and (2). *The residual percentage* is then the quantity to plot against the combined carbon percentages or any other test value being compared.

In order to do this a much more complete type of chemical analysis of the sample is required than is usually given, and in the actual melting work a "blank" test melt is required to get the quantity of manganese required for item (1). This "blank" is needful since the amount of de-oxidation demanded depends so much upon the manner of melting, the quantity melted per charge and the time taken for melting.

The Time Element.

This is where *the time element* enters. As is well known, the time factor in steel making is also of the utmost importance—it makes all the difference between poor tests and good tests upon any steel melt. I think that Mr. Shaw could usefully enlarge upon the need for thorough standardisation of the method of melting for research work.

This is possibly because it means too much very exact and systematic practical, and particularly analytical, work to suit the taste of the modern purely college-trained young metallurgists. They possibly realise that such research means much of hard work, slow reporting and deep thinking.

There are two important constituents in grey cast iron which you do not survey in the Paper, but which ought to receive attention. These are oxygen and nitrogen.

Estimating Sulphur Percentages.

For the determination of sulphur by the volumetric and the gravimetric method it is of course fully proved that in the majority of samples the two methods do not give the same results if applied directly to the drillings as received.

But it is equally proved (by personal experience) that if the sample drillings are correctly annealed prior to use in the volumetric evolution test method, the evolution and gravimetric methods *do* agree within the limits of experimental errors (the latter point must in all analytical work be honestly allowed for).

Now it is a fashion to consider gravimetric methods as always giving the exact or absolutely true values. Personally I do *not* consider that this is always the case, and in the case of the gravimetric sulphur determination it is frequently not the case, for there are few quantitative manipulation methods more open to incorrect manipulation than the gravimetric determination of sulphur in cast iron.

In one case which arose some years back I found that the way the gravimetric sulphur tests were conducted necessitated these being done in the presence of silicon determinations employing the sulphuric acid method; this was leading to a continual contamination of the sulphur determinations, with the result that the percentage of sulphur represented was always much too high.

One cannot accept gravimetric methods as the perfection of methods unless they are conducted with extreme care, according to thoroughly correct schemes of analytical procedure, and in a satisfactory environment. There is too much "sloppy" analytical work turned out in present-day laboratories. In the same way the volumetric evolution method needs very careful standardisation and equally careful work.

The modern colleges turn out rather poor analysts, and modern works and foundries frequently allow too little time for first class analytical work to be performed. Further, unfortunately few of the senior men, or those responsible for the issue of the results, take sufficient critical interest in the results put before them to prevent poor work being reported as correct.

I think this part of the Paper very useful, and it ought to rouse the young metallurgical chemists at such laboratories as the B.C.I.R.A. to make a thorough investigation into the two methods.

Personally, I and one of my former assistants did a considerable amount of work on the subject during 1902-1910, and my opinion is that both analytical methods are satisfactory if conducted correctly.

I never met with *free* iron sulphide (FeS) in grey cast iron, but I have done so in the case of white pig-iron and malleablised cast iron.

In grey cast iron the sulphur is usually present as manganese sulphide (MnS), but in very soft irons it is partly present in solid solution in the ferrite, and in medium to hard irons it is also present partly in a third form which is associated with the cementite.

Influence of Phosphorus.

I agree with Bolton that some of the phosphide is in solid solution in the ferrite. But he is entirely wrong when he states that it is only when the phosphorus is about 0.5 per cent. that the true eutectic of phosphide of iron is produced. Dr. Stead's early work on phosphorus is much more reliable and beautifully described. Dr. Stead shows microscopical evidence that even in hematite pig-iron of the greatest purity produced in England the phosphorus is present as the eutectic. It is, of course, a case where the rate of cooling and the amount of other elements present, especially silicon and total carbon, have very great influence.

Bolton is particularly incorrect in the question of the need of high pearlite for the separation of the phosphide of iron eutectic. We have done considerable work upon this subject, and the following are two out of many tests which prove that no pearlite (or very little) is necessary in order to get the eutectic.*

	Extra No. 1 Grade English Foundry Pig Iron.	Extra No. 1 Grade Scotch Foundry Pig Iron.
	Per cent.	Per cent.
Total carbon	2.91	3.55
Graphite	2.90	3.16
Combined carbon	Trace	0.39
Silicon	4.85	4.05
Sulphur	0.009	0.01
Manganese	0.36	1.23
Phosphorus (Total)	1.717	0.73
Phosphorus in solid solution ..	0.584	0.177
Phosphorus in Fe_3P (Eutectic) ..	1.123	0.517

These results show that in the Scotch pig, with higher combined carbon, there was less phosphorus present as solid solution (in the ferrite), and that about ⅓ th of the total phosphorus present was present as phosphide eutectic (Fe_3P). The above results are all percentages by weight.

It will be noticed that in the English foundry pig-iron there is no combined carbon (pearlite), and yet there is a considerable amount of both phosphide eutectic and phosphorus in solid solution.

Melting Practice.—Of course steel is not cupola melted, but on the other hand it is smelted, and the manner in which this operation is conducted and the time taken over each stage of the smelting process makes enormous differences in the chemical, mechanical, and microscopical properties of the product. So there are very good parallel data concerning steel and cast iron so far as effect of melting goes, and I strongly recommend the study of both sides—they are mutually helpful, as, generally speaking, the broader the metallurgical knowledge the sounder the deductions which can be made.

Research Suggestions.

I agree with the greater part of Mr. Shaw's comments, and hope it will wake up matters. I regret I am too pressed for time to deal further with this very interesting and stimulating Paper. There is a great deal of data in it which requires close examination.

* See also Table VI.:—"Specifications for Foundry Pig Irons," Part II. Proceeding. The British Foundrymen's Association, 1912-1913. Pages 268-304.

Mr. J. W. BOLTON, the well-known American Foundry Metallurgist.

This excellent Paper by Mr. Shaw brings out very clearly some of the practical aspects of grey iron research. With his usual keen perception he sets forth clearly, and in a refreshingly aggressive manner, three definite practical ideas. The writer is heartily in sympathy with the general ideas set forth in the Paper. However, there are a few points on which he is taking the liberty of commenting.

It is quite true that the analogy between the structure of steel and the structure of the matrix of cast iron has been sadly overworked. It has been clearly demonstrated that the usual path of fracture in grey iron is along the graphite flakes (Trans. A.F.A., Vol. 32, p. 523). Granting the greater strength of a pearlitic matrix, this matrix strength can be taken advantage of only when the amount, size and distribution of graphite flakes are proper.

The second point raised, namely, the basing of many broad generalities on results from smaller test bars, merits careful attention. The wide use of the so-called arbitration test bar has obscured the grey-iron research problem—the real problem being the production of the proper metal for castings.

It is pleasant to see the sulphur bugbear chased out of the spotlight. In recent work, from 2,500 diameters up, the writer still fails to find any evidence of sulphur network.

We used to have three convenient theories, viz.: (1) Sulphur network; (2) oxygen in the iron; and (3) phosphorus network. Recent American work demonstrates the untenability of the oxygen theory, as originally promulgated (Trans. A.F.A., Vol. 33, p. 431).

Stead's work on phosphorus is a classic. Unfortunately, Messrs. Cook and Hailstone did not make proper use of his results when advancing their theory of phosphorus network. The untenability of this theory has been shown in the "Foundry" (October 1, 1922, p. 787).

In the latter part of his Paper Mr. Shaw refers to a curve prepared by the writer for the Belgian Foundrymen's Association in 1925. Unfortunately, the inference from this curve is that it was made on an A.S.T.M. bar, and the editorial presentation suggests this. As a matter of fact, the iron cooling curve was taken from a large test bar, not the A.S.T.M. bar. This fact—not the difference in moulding practice—accounts for the differences observed between the cooling rates observed by Hamasumi and the writer. The things the writer was trying to show were (*a*) the transformation ranges of the particular metal considered, and (*b*) the heating up of the sand. Apologies are due Mr. Shaw for the omission of pertinent data.

Mr. A. CAMPION, F.I.C., one of the Pioneers of Foundry Metallurgy.

Mr. Shaw does well to draw attention to the erroneous idea that cast iron and its properties can be studied on the lines of a carbon steel. I agree that this idea has been responsible for many absurd statements, and has led to many failures and disappointments among founders who have tried to produce high-class castings by such deductions. The mistakes have largely arisen from confusing the relation of ultimate chemical analysis and physical properties, instead of considering the constitutional analysis with properties. The simile with steel can only hold from a metallographical point of view where there is some ground for considering the micro-structure as a matrix of pearlite or ferrite cut up with graphite and phosphide, but here again the composition of the pearlite or ferrite are not the same as in steel.

After all, steel can be considered as binary or ternary alloys more or less pure, but cast iron is a complex conglomerate, and we really have to deal with the resultant of a large number of factors acting at variance.

Alloying and Inherency.

As regards the condemnation of the synthetic method, I presume that Mr. Shaw is referring to the theories which have been advanced by various workers from time to time based upon experiments of adding various things to a base iron, usually white iron. In that case I entirely agree with him as to the unreliability of the method. In the first place, it is practically impossible to ensure that all additions are made under precisely similar conditions, and secondly, the effects of these additions are not the same as the same quantity of the element introduced into the iron during smelting in the blast furnace. Just as brass made by the old calamine process possessed properties rather different from that made by melting together the same proportions of the constituents, or a more modern example is Monel metal when made by direct reduction of the ore gives remarkable results, but melting together iron, nickel and copper is quite unsatisfactory. I have always considered that the same thing occurs in the smelting of pig-iron; in fact, I have frequently tried to imitate a certain result by making additions to the ladle, but have always found that the result is inferior to that obtained from pig-iron of equal composition. It seems that there is some molecular change upon which inherent properties of the metal depend. For the same reason I have for many years advocated in mixing to analysis of cast iron and especially steel-mix irons that any additional manganese, chrome, etc., be added to the cupola, and not as rich alloys to the spout or ladle.

Initial Temperature Attained.

Then there is another very important factor, one which to my mind has never been given sufficient attention, that is, the initial temperature, by which I mean the maximum temperature to which the metal is heated in the cupola, and the length of time of contact of the highest point. I feel certain from the results of many years' observations that the variations in this respect is responsible for many conflicting results obtained on irons cast apparently under the same conditions. Casting temperature has been shouted for years, but I do not for one moment think it is of so great importance as is usually stated. I believe it is of secondary importance to initial temperature, not simply on account of greater fluidity, but rather because it induces certain molecular conditions, and also that the question of nuclei comes into the picture; the higher it is heated the more complete is the destruction of free-carbon nuclei, and consequently the more evenly distributed and the finer is the graphite.

As regards the carbon and silicon relationship, I do not think that the modern idea of using the sum of these elements as a means of controlling high-test iron is of any value except under very, very narrow conditions, as, for instance, where one of them is fixed in amount and all other elements constant. I believe that the ratio of toal carbon to silicon, coupled with the ratio of combined to graphitic carbon, has a more important bearing on the strength, etc., although Cook's formula does not express what I mean, it is empirical entirely, something much more fundamental is required.

Silicon Control.

This has been carried to an absurd length, but the quotation given from Keep is perhaps hardly germane to the point, because he was not dealing with high-grade material such as we are thinking of, but only iron of the repetition order for light castings, where truth and straightness were the only things troubled with. Strength, so long as the castings could be handled, not being considered.

The whole of the literature of the influence of elements on cast iron is unsatisfactory. It is practically impossible to compare one set of results with another owing to varying conditions of methods and material. One cannot compare the results of crucible-melted material with cupola-melted, and even with cupola-melted metal; there are the variations of cupola practice. Confining myself to my own experience with cupola metal, I have no hesitation in saying that the sulphur idea has been grossly exaggerated, and this element has been made a convenient scapegoat for unexplained ills. Actually, I believe that very low sulphur is a disadvantage, both in regard to strength and heat resistance. The best ingot moulds for large steel ingots that I ever used contained over 0.15 per cent. sulphur, and I had them made with this percentage purposely, as with care in the first few heats they took on a splendid skin and had long life. The

sulphur-manganese balance theory is by no means proved, and, personally, I doubt the correctness of it. Sulphur, in my opinion, seldom exists as simple sulphide of either manganese or iron, and any masses of so-called manganese sulphide act mechanically rather than chemically.

Half per cent. Phosphorus Not Deleterious.

As regards phosphorus, my views are well known. I never have advocated the reduction to under 0.1 per cent. even for Diesel work; in fact, I have consistently preached that very low phosphorus was not only not necessary, but actually disadvantageous. I believe in having about 0.4 or 0.5 per cent., because at this you get maximum solidity and fluidity. I have experience of Diesel liners doing many years service with practically 1 per cent. phosphorus, and I have no experience of the brittle range which has been mentioned.

Manganese for Diesel Engine Cylinders.

Manganese no doubt does cause graphitisation round about 0.5 per cent, but for high-test iron such as Diesel work, I find from experience that this percentage is insufficient. I always recommend for Diesel work over 1 per cent. manganese with low silicon. Personally, I believe that temperature is responsible for the alleged manganese graphitisation, which varies with silicon and carbon content of the mixture.

Mr. Shaw refers to the good results obtained with high manganese as regards strength at high temperature and growth resistance. These results have also been obtained by me, and, in fact, I made some of the material for Donaldson's experiments. Mention is also made of the results on small bars being incomparable with thicker sections. Now, when working for the Diesel-Engine Makers' Research Committee, I had cast Diesel liners to which test bars were attached and separate bars all from the same ladle. It was found that the results agreed very well on the bars cast-on and separate with bars cut from the liners. The liners were all cut up and thoroughly tested in various ways both at normal and elevated temperatures.

The Sulphur Chill.

I am in the main in agreement with Mr. Shaw's remarks regarding sulphur. There is no doubt that increasing sulphur increases the depth of chill, and also the CC. I am, however, not in agreement with the remarks about equilibrium, as it is rather inferred that the rolls which take five or six hours to set must have reached equilibrium. This, I think is quite wrong. As a matter of fact, complete equilibrium never is attained under industrial conditions. It would be necessary for solidification to be excessively slow and the temperature to be maintained near the freezing point for days or even weeks. A well-known example is 70/30 brass, which never shows a perfect structure and equilibrium under ordinary working conditions; it has to be kept at a high temperature for a very long time to reach such a state. If a simple binary solid-solution alloy is so difficult to get into a state of equilibrium, how can it be expected that so complex a material as cast iron will do so? Here we have another clue to some of the contradictory results with cast iron—various stages of equilibrium—due to varying temperatures and cooling velocities, and the number of points from which graphite deposition starts, or the question of nuclei already mentioned. These sort of things have not been considered of any importance by many students of the metal, but nevertheless I am sure they are determining factors in many cases.

Regarding the second portion of the Paper, I agree thoroughly with Mr. Shaw's strictures on the insurance people referring the investigation of cast iron to steel metallurgists, who are too proud to admit their deficiency and refer it to someone who does know something of cast iron. The closing paragraphs should be put very prominently before the engineer and founder repeatedly until they cannot forget it.

Mr. HARRY M. LONGBRIDGE, Managing Engineer to the British Engine and Electrical Insurance Co., Ltd.

We notice that Part 2 of Mr. Shaw's Paper contains the words "where criticism has failed" in the title. As this refers in the main to our Technical Report, we should like to point out that he has misunderstood the spirit of our report. It is in nowise written in a spirit of criticism. It primarily purports to describe examples of failures experienced by this Company during the year under review. Any secondary purport lies in the offering of suggestions for the improvement of methods of design and construction of the particular part that failed, whether it is made of wrought or cast steel, cast iron, or non-ferrous material.

Reason for Absence of Cast Iron Micrographs.

We notice that on account of the absence of photo-micrographs of cast iron Mr. Shaw reaches the conclusion that we are not conversant with this subject. Granting that were so, we happen to be members of the British Cast Iron Research Association, and have facilities should we so desire for submitting any case of failure to their consulting metallurgist, from whom we are able to obtain a full report. As a matter of fact, in spite of our alleged lack of conversance on the subject, we find ourselves regularly asked by clients our advice with regard to design and mixings, and we have always found manufacturers in hearty co-operation with us and ready to benefit by our experience and accept our suggestions for better construction of replacement castings, and again we are daily in receipt of requests from manufacturers to overlook their drawings for new constructions, and make suggestions for their improvement. We have made many examinations of microstructures of cast iron for clients and on castings that have failed, but, as Mr. Shaw says, we have not published the photo-micrographs in our reports. The reasons for this omission are as follows:—

1. Our Technical Report is primarily an engineering report, and not a metallurgical report. The matter that we choose for publication is that which we consider will interest the bulk of our readers who are not ironfounders or metallurgists. When we do publish a photo-micrograph it is done expressly to illustrate some point that a non-technical reader can readily appreciate, which he cannot with the complex structure of cast iron.

We are regularly carrying out experimental work on cast iron with a view to correlating its properties with its microstructure, and we have carried out many experiments to determine the effects on cast iron by various heat treatments. In any conclusion, therefore, that we name, we find ourselves in a position to form our judgments with confidence. Up to now we have hardly considered such matters as being of general interest to our readers; we did, however, give some results relating to the graphitisation by corrosion, narrated in brief in our Report for 1922, pp. 63 to 66. Our report already far exceeds its original size, and it would be impossible to extend its activities to every class of metal, especially when those interested in cast iron can obtain mass information from the records of the B.C.I.R.A.

Cast Iron Micro-structure Not Responsible for Failures.

2. With the exception of a faulty casting it is unusual for a failure of an ordinary grey cast iron to be due to anything faulty in the micro-structure, a very different proposition from steel or other metals. This, in general, is on account of a larger factor of safety. The fault in by far the majority of cases is due to improper design or overstress. When the fault is due to faulty design it is our object to protect the manufacturer as much as possible, and we therefore refrain from giving drawings and full particulars. For this reason, though nothing may be stated in our report, we are daily altering the design of such cast-iron parts as steam cylinders, pistons, fly-wheels, valve chests for pumps, bedframes, breech ends for gas and oil engines, and every kind of cast-iron vessel containing steam under pressure.

In writing the Report, however, we endeavour to protect manufacturers as much as possible, and as publication of drawings or fuller descriptions would make it clear who the maker was, we find ourselves forced to content ourselves by stating, "the design of the part was suitably altered to resist the stress." We only depart from this rule when we consider that the design is very culpable, such as the case Mr. Shaw reports of ribs in a turbine casing which prevented the natural breath of the casting. Occasionally we are able to give a brief description, such as in Case 3, pp. 31 and 32, 1926 Report, where we made a complete alteration in design, and in such cases it is usual for us to be asked by clients to supervise the design and construction of replace castings when they fear trouble.

Mr. Shaw insists that an impression is given that we consider cast iron an unreliable material. We are unaware of a single word in our Reports that would lead to that conclusion being reached. This most certainly is not our opinion. A similar impression could be gained equally for any other metal.

Mr. Shaw states that many of our conclusions are open to serious doubt. We wish to point out that his only named illustration of this contention, No. 2458, is in nowise based on our investigations or is a failure experienced by this Company. If Mr. Shaw refers to the title page—page 73—he will see that the case is a summarisation of a Board of Trade Report that is given without the slightest comment from ourselves. We can take no responsibility for any verdicts given there, investigations where carried out for the Board of Trade being conducted by the National Physical Laboratory.

Where Cast Iron is Obsolete.

In reply to this point we might mention that the use of cast iron under the conditions described is entirely obsolete in this country. This is on account of numerous failures. Surely Mr. Shaw has overlooked the fact that the steam belt contains steam at the full boiler temperature and pressure. Should a turbine of this design be offered for the temperature named, it would be a matter for surprise if the maker could find an engineer in a single power station in this country who would accept it.

We make and have no charge to make against cast iron. It is, however, universally recognised to be unsuitable for use with superheated steam, the result of experience with all who have the responsibility for the running of steam plant. We think that many of Mr. Shaw's comments would be modified were he as well acquainted as we are with the running of steam-driven power stations, with the Board of Trade and Lloyd's Regulations, and with the Factory and Workshop and the Boiler Explosion Acts.

We do not know to which case Mr. Shaw refers, but examples experienced by us are numerous where contraction cracks have been formed before the casting has left the foundry. Such defects develop under the conditions of service. When their presence is discovered they are closely watched, but they sometimes run for many years before their use is deemed unsafe. We ourselves should not have classified contraction cracks as a charge against cast iron; in the absence of the reference it would appear that a more appropriate classification is improper design or improper mixing.

Mr. Shaw's words, "a wholesale condemnation of this sort." The condemnation we made lies solely in the use of cast iron for high-temperature steam. The writer of the Paper gives no reference for us to refer to the case, the facts, however, we recollect. The second part of the sentence should perhaps have the words "when used with superheated steam" added to make the words, in the absence of the context, correspond with the writer's intention when he wrote the report. The Company certainly does maintain that cast iron is not a suitable material for the purpose; nor is it aware of a single manufacturer of repute who would supply cast-iron seatings for superheated steam. The trouble lies in existing valves being used for purposes for which they were not intended. For a disc valve one objection is that it is liable to graphitisation, and we have on many occasions crumbled the metal that has been sound between a finger and thumb. Our second point was only incidental, merely pointing out that while trouble is usually confined to the part itself, here the broken part caused consequential damage elsewhere, a by-no-means isolated instance.

(To be continued.)

Improved Methods and Lower Costs.

By Léon Thomas, President of the French Association Technique de Fonderie.

Equipment and Lay-out of Works.

We have all known and still know a large number of foundries in which, and particularly round about which, there is complete disorder and nothing like system prevails.

It is clear that all manufacturers are not in a position to tie up large amounts of capital in installing modern works equipped with all improvements and designed for the purpose of reducing the cost of labour as far as possible. In certain cases they have possibly transgressed more seriously, and that if they took into account—as they logically ought to do—amortisation, rent of premises and their maintenance, they might observe that the cost of working is costly.

It is proposed to submit certain measures of order and method which are almost systematically ignored in many old foundries, and to stress certain general principles which ought to be observed in planning a new foundry, and which hold good whatever its situation, its size, and the particular line of manufacture for which it is intended.

A Typically Bad Foundry.

In no industry are there examples of greater dirtiness and disorder than that seen in the immediate vicinity of the majority of foundries. For instance, in the raw material yard, piles of pig-iron arranged anyhow; a wagon-load of phosphoric pig mixed up with hematites of different compositions; the runners and foundry waste without any sort of classification; the coke, sometimes protected by a shed, sometimes in the open air; sand and limestone dripping wet in winter; weighbridges uncleaned and never tested.

In the box yard, the stock all in a heap, neither arranged nor kept in condition; certain sizes carefully preserved when it is known that they will not be wanted more than once in ten years; others, sometimes broken even when they come from the foundry, when it is known that they have to be used next day. This box yard is a veritable rubbish heap where the most heterogeneous objects are to be found. If one enters the foundry one feels as if one were about to be asphyxiated, for the atmosphere is almost unbreathable. Fortunately, there are generally enough draughts to restore the visitor, who has next to accustom himself to a gloom which sometimes becomes total darkness. The windows and skylights are covered with a perfectly opaque sheet of soot and dust, and as regards artificial lighting, it is always insufficient. Then, after accustoming oneself to the surroundings for a few minutes, one may think of going through the shop. But with what difficulty! In a chaos of pit moulds or box moulds, copes waiting to be fitted, empty boxes, and, above all, heaps of sand; everything lying anyhow, without any order or any idea of inter-relationship, for every workman places himself wherever and however he chooses. Thus, it may be found that in a foundry producing castings of different kinds more than half the covered area is practically unused. In the machine-moulding shops some degree of order is obligatory owing to the fact that the machines are stationary, but even there how much still remains to be done!

Bogey Holes!

This is the general impression, but what disagreeable and painful discoveries one would make if, surmounting the obstacles intentionally or unintentionally placed in one's way, one were to inspect one of those repugnant corners which 30 years of foundry life has taught the author to discover—the benches for core making, the hearth and roof of the drying stoves, underneath the cleaning benches, the casting pits, the vicinity of the cupola, etc.

It must be admitted that this disorder is due to lack of care. A little observation will show this, while a good application of energy and persuasion would enable it to be corrected, and this would mean the first step towards rational organisation. This, moreover, is within the reach of everyone.

Fundamentals.

The planning of a new foundry essentially implies certain fundamental considerations:—

(*a*) The provision of adequate ground area, remembering that order is dependent on the space available, not only as regards the actual workshops, but also as regards sheds and yards.

(*b*) In selecting the method and type of building, account must be taken of the fact that the atmosphere of the works will be damp and dusty, with noxious emanations in suspension.

(*c*) To minimise the evil effects of this state of things, which we must accept both as affecting persons and material, the aeration and ventilation must be improved as far as possible.

THE Rationalisation of the Foundry Industry, coupled with a modern costing system is urged in this article, which was presented by Mr. Leon Thomas, the President of the French Foundry Technical Association to the recent Spanish Foundry Congress. The author's great experience as manager of the Citröen Foundry in Paris, a position he has recently relinquished, renders his pronouncements on foundry technique worthy of serious consideration by all engaged in the industry.

(*d*) For the same reasons the lighting conditions by day and night must be improved as much as possible.

(*e*) It must not be forgotten that, in moulding, sand is necessary, that the quality of the sand is an essential factor in the value of the castings, and that all machines work under poor conditions and are subject to great wear, so that a considerable co-efficient of safety must be provided; their construction must therefore be very strong and their maintenance must be ensured.

(*f*) The arrangement, dimensions and regular operation of the stoves and different drying apparatus are likewise of great importance; the same applies to the melting plant, and the progress of modern technical science involves such work-coefficients for cast metals, and for cast iron in particular, that the best installed cupola will not suffice to effect the liquefaction of a sufficiently pure and sufficiently homogeneous product, and that "duplex" working will be essential; it will consequently be necessary to reserve space for this purpose.

(*g*) The nature, number, and power of the cranes are of the greatest importance, as such machinery is costly, and therefore requires a minimum amount of work and output to justify its installation.

(*h*) Finally, it will be well to remember that if the nature and size of the projected foundry justifies it, proximity to a railway or a navigable river is an important economic factor.

Manufacturing Conditions.

At the basis of rational and scientific organisation in foundry work must be placed the study of the manufacture of the casting which has to be turned out. It is not so long ago that the series of operations in the production of a casting was as follows:—

A designer or draughtsman, without the smallest idea of what moulding means, prepared a sketch of the casting. A pattern-maker, left entirely to himself, made the pattern and the accessories required. The foreman handed these working materials without the slightest instructions to a moulder, who assumed the entire responsibility for the proper production of the casting.

It is obvious that this simple method, while it brought out the technical qualifications of the pattern-maker and the moulder, involved a danger: that of being entirely dependent upon the technical skill of these two workmen. In any case, this process did not help to raise the prestige of the draughtsman, and particularly of the foreman, and it rendered almost illusory the previous determination of the cost of the casting and the time required for its delivery.

Founders are now beginning to understand that the details in the manufacture of a particular casting must be studied in order to see first of all whether it can be produced practically, for this enables the designer or draughtsman responsible for its design to be notified of possible improvements, and also in order to decide what devices will have to be adopted to produce the casting with the maximum guarantees in regard to sound manufacture and accuracy in the minimum time and at the lowest cost. Theoretically, this is very simple, but practically, the problem is complex.

Obviously, it is not difficult to make a loose sort of examination, with a few lines to locate the surfaces to be joined, which are indicated in colours, to show the parts of the boxes, the sand, and the cores, and a few more lines indicating the runners and vents. This method will make the foreman and workmen smile without contributing anything to the solution of the problem, for all it does is to apportion responsibility in the event of difficulty.

The study of manufacture being based on a more comprehensive programme, the limits of this Paper allow of the outlining of:—

(*a*) A plan of the mould, absolutely complete, with working dimensions of the casting to be produced, and all the manufacturing accessories—boxes, sand, core irons, vents, runners, cores, fixing devices, etc.

(*b*) Detailed plans of the patterns, core boxes, fittings, necessary auxiliary machines or parts, templates, etc., with exact indications of the plays or tolerances.

(*c*) An exact and complete specification (1) of the materials to be employed (sand, loam, binding material and blackings); (2) of the precautions to be observed in drying or heating, moulding, assembling, tapping, delivering, cleaning and testing; (3) of the metal to be used for the casting (analysis, nature of the mixture, percentage of fuel and flux, temperature, physical and mechanical properties); and (4) of the times and prices to be allocated to the different individual operations.

A programme of such extent obviously calls for particular qualifications in the person required to carry it out, for he must possess technical and practical knowledge of the work, adequate experience of the means at his disposal and of the workmen whom he directs; but, after all, these are precisely the qualifications of a manager. The highest qualification of a manager—that which gives him the greatest prestige in relation to his colleagues and complete authority over the staff he directs—is precisely the fact that he is capable of working out and preparing the ensemble as well as the details of a particular product to be manufactured.

To summarise, the preparatory work on an article to be manufactured should fundamentally consist of:—(1) Technical studies; (2) control or examination of material; (3) control or examination of the casting produced; (4) time studies; (5) measurement of times; (6) testing; and (7) starting up.

This implies the existence of a planning office with a qualified technical staff; a pattern and testing shop, which would be a real foundry laboratory; and a rational system of grading in the supervisory staff.

Notwithstanding its complexity, which is more apparent than real, this system of organisation is the only one capable of enabling the shop ex-

perts proper to perform their true function of executants, of allocating to everyone his exact share of responsibility, and of constantly providing the accountancy departments with the data enabling them to estimate costs.

It can be stated, after having tested it for a long time, that this system always has given—with more or less precision according to the importance of the products with which the management was concerned—fruitful results; whereas the greatest difficulties were encountered whenever the direction was led by considerations, more apparent than real, of time of delivery or economy to abandon its application and to relapse into the old haphazard custom.

In a trade so abstract as foundry work, in which there are so many variable factors, one may truly say that "Success means foresight, and foresight means study."

Plant and Tools.

In referring to the installation of foundries, the minimum amount of plant which they ought to have has been indicated.

For a long time, and almost generally, this material was very slender. A cupola constructed by means of an old boiler tube; a mortar mill for preparing the sand; and some cranes with wooden slewing arms. These were the essential elements.

Since the beginning of the century enormous progress has been made, and specialising firms now supply founders with perfectly suitable apparatus which have stood the test of time. Their adoption is dependent upon their cost, and the fact that savings can be effected more particularly in handling and distribution, since the work demands much of this and of a most varied nature, should be emphasised.

Apart from the other equipment in a foundry, the *moulding machine* plays an important part. Just as a machine tool is useless without the accessories which complete it, a moulding machine requires important accessories in the shape of plates, boxes, etc., the design and construction of which determine the output that can be obtained. Only by preliminary study can a sound system of working be laid down.

As regards the boxes, their standardisation to certain dimensions is necessary, and they must be accurately centred over each other, so as to be interchangeable—a point which many workmen ignore. The placing or fitting of the boxes over each other requires care, particularly as considerations of weight have frequently to be taken into account, and as the question of cost must never be lost sight of.

This also applies to the pattern, which may vary from a simple wooden shell to the elaborately cut bronze pattern mounted rigidly and very accurately on a plate, and capable of remaining intact after thousands of castings have been produced.

The core boxes are also of great importance in the production of certain difficult castings, such as cylinders or heater units. After having long regarded the core as a difficulty which had to be overcome even at the cost of the most improbable devices, the advantage of extending their use, which sometimes enabled highly complicated castings to be executed in green sand, was discovered. Since then the employment of female labour has led to the special conception of light apparatus, of clean and hygienic raw materials, of separating complex work into its elementary factors, of the rectification of consecutive joints—a conception which has been carried to such a degree of perfection that one is able, for example, to solve the following problem with complete success:—

To core up and close simultaneously in 30 seconds the moulds for the crank-case, the valve seats, the water jackets, and the inlets, exhausts and grooves for a complicated cylinder casting for a motor car.

Apart from the principal articles of equipment, how many of the details in foundry work could be standardised—the rammers, rules, gauges, core irons, joint ties, loose bars, wedges, washers, clamps, gaggers, cupola tools, cleaning tools, etc., etc.

Standardised Tools.

How much time and money would be saved if all these elements, manufactured in quantity, stored conveniently beforehand, and distributed as the orders require, were estimated at their real value, instead of being lost one after another in all the corners of the shop.

In an important foundry the author was able to compile an inventory, comprising 200 pages, containing the various tools made with his own resources. These were regarded as outside supplies, and were accounted for as such, each shop and each workman being constantly responsible for those furnished to him. Could not these principles of orderliness be applied also to smaller works?

Recruitment, Duties and Remuneration of Staff.

In no transforming industry—in foundry work as in other trades—can the fact be disregarded that labour is an essential factor in cost, and that this will be directly affected by the output and technical competence of the staff. If, moreover, as is logical, one estimates the productivity of the entire staff of workers in the business concerned, together with the cost of the raw materials or the accessory products used in the work, it can be seen that this factor, which is regarded by everyone as a bugbear and which one describes without more ado as overhead charges, can be reduced to its simplest expression.

Overhead charges were unknown in the old foundries of the past, when the moulders themselves prepared the sand, blacking, core-irons, gaggers and boxes and provided the pins or nails and the runner boxes—in short, all the accessories required. These costs were at least sufficiently low to be practically negligible.

If they were then little more than non-existent it is difficult to image why, while not entirely so to-day, they should in certain foundries be a burden on the cost price up to as much as 300 per cent. of the amount paid the direct workers. In any case the very fact that they are generally calculated in proportion to the labour proves that they are directly dependent upon it.

The recruitment of labour in foundry work is at present attended with difficulty owing to the crisis in apprenticeship generally, the objection of workmen to a trade which they regard as particularly dirty and fatiguing, and the lack of initiative on the part of the foremen, who frequently do nothing to make the work cleaner, easier and more remunerative.

Serious efforts are at present being made throughout the world for the purpose of finding a solution of the very complex problem of apprenticeship. Although tardy, founders ought to encourage these efforts; but they require to be prosecuted with a certain amount of tact for, as has been truly said, industrialists must avoid at any price filling the factories to the detriment of agriculture. It would be better to close the factories for lack of labour than to leave the land uncultivated for the same reason: and it must be admitted that without insuperable difficulty founders could utilise the human material available much better than they do as a result to the development of machinery.

But to accomplish this employees must be educated. The author has frequently had to criticise the work of moulders who spent half their available time in ramming the sand with the fragment of a casting or a piece of iron fitted into a wooden handle as a rammer, and who long showed themselves obstinate against the use of the pneumatic rammers with which they were provided. Similarly, it took years to make them understand that a machine was necessary for the manufacture of large quantities of a particular casting.

In the course of a recent conversation with an engineer who had lived many years in the United States the author had occasion to discuss the mentality common to the immense majority of European moulders, who take no care whatever in preparing their sand and are surprised at the numerous tears and breaks which they discover on withdrawing the pattern.

Dearth of Managers.

It is for the manufacturer or his representative to organise the work under conditions of cleanliness in a healthy workshop, but the rendering of the work less arduous depends on the workman.

Who is responsible for the education of the staff? Unquestionably the directors of the foundry (the foremen and works managers). Founders are suffering from an apprenticeship crisis and even a labour crisis, but a crisis affecting the supply of foremen and works managers is even more serious. There is no lack of candidates. But some have come from the ranks and retain the mentality they had when there were manual workers, and they even aggravate this by imagining that all they have to do is to shout sufficiently loudly to be obeyed. Others are more highly educated and trained, but, owing to lack of practical experience, they think that a foundry can be managed from the office, with one or two visits a day to the shop, to which they soon take a dislike, particularly if there are difficulties which they are unable to overcome or, more generally, because they have no idea of the attitude a manager must observe when he visits a shop during working hours.

There are many technical schools for secondary or higher instruction which provide educated young men possessing a very respectable scientific equipment; they have at their command a certain "documentation," which they supplement daily in respect of theoretical considerations which enable the work to be improved and which they have, as it were, codified in the form of maxims, such as the following:—"Progress is always possible," "There is no work that cannot be improved," "The greatest benefits are due to the improvement of operations performed haphazard and without method," "Method is desirable in the expert workman as well as in the apprentice," "A decision should always be based upon facts, *i.e.*, on something concrete which it has been possible to express in figures and to verify," "Avoid the three pitfalls: (1) Preconceived ideas (prejudices), (2) defective supplies, and (3) raw materials varying in quality."

When some of these new recruits, after having lived intimately and courageously the life of the foundry, and acquired *ipso facto* an adequate measure of technical knowledge, come to occupy posts as managers (foremen or shop managers), they will possess all the requisite qualifications to convince their subordinates, who were previously their fellow-workmen, that the improvement of the worker's lot is essentially dependent upon increased production, of which the workers are masters, notwithstanding all the improvements and automatic devices that may be placed in their hands or at their disposal.

Just as the success of an undertaking depends on the worth of him who works it, so the output of a shop is dependent on the qualifications of the man who manages it, a fact which was embodied in the old dictum, still applicable to-day: "The worth of the man is the worth of the business," which we may paraphrase thus: "The worth of the manager is the worth of the workmen."

Accountancy and Costing.

Study must constitute the basis of the rational organisation of labour, but accountancy must constitute the coping stone, as this is, in a certain sense, the only instrument of measurement which enables the value of the results to be determined. The sole purpose to be prosecuted by all the collaborators in an industrial undertaking, from top to bottom of the social scale, from the owner to the youngest apprentice, is to make money; but it is not so easy as it might antecedently appear to determine whether a piece of work is productive or has been done at a loss.

In a manufacturing company, in fact, the directors and all those invested with some measure of authority, who possess a minimum of technical knowledge, have a tendency to allow themselves to be easily impressed by some particular manufacturing system or process, or by some particular original machine which they have been, or think they have been, the first to use, and they draw the conclusion that the results obtained must be automatically remunerative, whereas the reverse is very frequently the case.

Accountancy puts before those concerned definite, concrete figures, which leave no room for hypotheses or illusions; still better, indeed, if the system is complete and is properly expressed, it effects an automatic check on the output of all departments of the works, if not the output of each individual worker.

The smallest undertaking naturally requires to keep a certain number of books in which general results are registered, but unfortunately these give no definite particulars regarding the working of any particular department or any particular shop. In certain firms which were better organised efforts have been made to institute a manufacturing accountancy, almost without any relation to the general accountancy system, but this provided only statistical results which might be made to indicate almost anything that might be desired.

After having made a serious study of all the aspects of the question the author succeeded in organising an accountancy system designed in accordance with a fixed directive plan, applicable to any industry, capable of covering minute details, but the mechanism of which is in permanent and intimate contact with the centralising organism which summarises all the detail operations.

It may be interesting to give a short account of the application of this system of accountancy to a foundry, situated, for example, at a distance from the central office, and forming merely a department or section within the general organisation of a company, which consequently has no direct connection financially with the supplies, the customers, the banks, the shareholders and the board of directors. In this form the scheme of accounts omits Sections I and II and will contain only the following principal subdivisions:—

Section (III) Cash; (IV) Credits and Debits; (V) Stores; (VI) Productive workshops; (VII) Workshop costs; (VIII) Profits and losses (charges); and (IX) Temporary accounts.

Mr. Thomas then detailed a system wherein an account was opened for every material used in the department. They are numbered according to the following manner:—In Section VI every account is prefixed by 600 or a sub-division such as 610 for iron and steel, and 620 for malleable castings. Then this is followed by a second number of two figures which further identifies. Thus the manufacture of malleable castings for stock is 620.40. A further feature is that the stores (Section 500) will make a balance-sheet which will take in on its credit side all the debits shown on the manufacturing departments accounts. Mr. Thomas, continuing, pointed out that this scheme, which appears very complicated at first sight, possesses many advantages. It is essentially capable of extension and permits of the inclusion, according to requirements, of as many accounts as may be necessary or desired, as, for example, when it is necessary to pay special attention to some new manufacture. It is based on a rational classification of the various phases of the work, and reduces the amount of overhead charges to the minimum. Moreover, it shows immediately, at any moment, whether the business is going satisfactorily or otherwise by simply examining a balance consisting of sixteen figures (the credits and debits of each of the seven sections plus the totals) the general position of the business from the financial point of view can be seen immediately. By means of comparison and analysis it can be ascertained which of the different productive sections are profitable and which not.

Section III comprises the cash operations; its operation is in a certain sense automatic. Section IV (Debits and Credits) is greatly simplified in the case of a foundry which has only one supplier (and also one customer), the X Company to which it belongs and which provides it with the necessary working capital, raw materials, miscellaneous equipment and supplies, orders, etc. All the foundry's products are intended for the company. The section has consequently only two main divisions: 410 the Company as customer X, always debtor, 450 the Company as supplier X, always creditor. It is indeed the balance of these two accounts that gives the balance for the foundry.

Section V (Stores) is important. The efficacy of every system of accountancy is dependent on its exactitude, for it records all the incomings on the one hand and all the outgoings on the other. To permit of frequent test examinations during the business year all the sections or departments must be provided with permanent inventories.

This involves the institution of a strict system which prevents the delivery of any goods without the previous presentation of a voucher made out in regular form, approved by the responsible works manager, giving exact particulars of the order, together with the exact number of the account concerned.

Moreover, effective supervision cannot be exercised without a single supply store centralised in one place, as the manner of exercising it is essentially dependent upon the responsible manager, and it has been proved that supervision is extremely difficult if it has to be exercised at different points. The application of this principle in a very large works covering many acres which the author has known for years had led to a system of handling which might antecedently have appeared expensive, but the cost of which was amply made good by the savings effected by centralisation.

Raw materials which are heavy or bulky, such as pig iron, steel, fuel and sand should, of course, be stored as near as possible to where they are to be used; but they should remain as long as possible under the control of the central store, unless the latter issues it in bulk (*e.g.*, a wagon load of sand for a particular casting), when it is seen that its distribution cannot be supervised.

An excellent practice, adopted in certain American foundries, consists in weighing the ladles or shanks of liquid metal before it is carried to the casting shop; this permits of double supervision of the weight of the untreated metal charged in the melting apparatus (taking into account the melting loss) and of the weight actually poured into the moulds. It is desirable that this practice should be adopted in all foundries, and in any case it is indispensable in those which work special metals (aluminium and copper alloys, etc.), where, if the weighing of the crude charge is properly done, the melting loss can be estimated exactly, while the weights of the castings and runners are also definitely determined. This practice also enables the different losses between melting and shipment to be checked.

Against every particular manufacture it is desired to follow up, one should establish a temporary store account. For example, workshop 610.10, "manufacture of castings, Series A," will have as its sole customer the corresponding store 526.10. It is clear that this department operates only on paper, as the castings concerned (some of which may weigh several tons), in so far as they have left the foundry, will have been tested as to weight, quality and value, and will be sent directly to the finishing shop or to some other works belonging to the company or to the customer. But from an accountancy standpoint the author regards this "Store" account as indispensable, for it enables the item to be credited at once to the producing workshop and the raw materials previously delivered by one of the sections of the supply store to be checked, while it also facilitates supervision of the shipments.

The account "Pattern Store" 587, which constitutes one of the credit items of the Company, will always be strictly balanced and will not appear in the balance of the foundry.

All the new patterns made in pattern shops 650.05 (wooden pattern shop) and 10 (metal pattern shop) (regarded as productive workshops) will be invoiced and debited proportionately according to account 410.60 (miscellaneous patterns).

Section VI (Productive Workshops) comprises all the work of manufacture and enables the exact cost of all the castings produced to be determined.

Under the heading "Workshop costs" (Section VII) there has been classified the subsidiary manufacturing shops; the wages paid to the staff; all the accessory charges, each account being balanced by a corresponding account for costs recovered, according to the cost price slips.

Thus the account 720.05 "Work on cores for cast iron" might appear as follows:—

720.05 *Cores for Cast Iron.*

500.30	To supply store: fatty materials (for binding material)	
560.60	To supply store: iron and steel (for core irons)	
735.05	To stoves and melting furnaces	
750.05	To labour, production, cast iron	
750.10	To labour, accessories, cast iron	
870.10	To overhead charges (salaries of staff, manager, foremen, etc.)	
	Etc.	
	Total	
765.05	By cost of manufacture, castings series A	
765.10	By cost of manufacture, castings series B	
165.40	By cost of manufacture, miscellaneous stock castings, cast iron	
765.50	By cost of manufacture, miscellaneous steel castings	
	Etc.	
	Total	

The accounts "Manufacturing costs" and "Costs recovered" operate as shown below:—

765.05 *Manufacturing Costs, Castings Series A.*

720.05	To cores, cast iron	
726.05	To sand	
730.05	To lighting	
650.05	To pattern shop	
	Total	
766.05	By costs recovered, castings series	
	Total	

766.05 *Costs Recovered, Castings Series A.*

765.05	To costs of manufacture, castings series A	
	Total	
610.05	By manufacture of castings, series A, as per details of cost slips	
	Total	

Section VIII has been labelled "Profits and Charges," as it comprises the various charges borne by the works, and contains also the sales of the articles manufactured.

The account "Goods for sale," 800.05, is debited with the value of the castings supplied by the different Stores 526.05, 536.05, 546.05, 556.05, 576.05, 586.05 and credited by the account "Sales" 810.05.

The account "Sales" is debited with the value of goods derived from the preceding account and credited by account 410.05 to 50, according to particulars of the invoices accompanying the different deliveries.

The items of the account "Overhead Charges," 870, are debtors in respect of Cash 300, and are, of course, credited by "Manufacturing Costs" for the monthly salaries of managers and foremen, or else by "Overhead Charges Recovered," according to the abstract of the corresponding amounts applied to the statements of cost.

The temporary accounts of Section IX permit of the ordinary method of bookkeeping being preserved, and even in the event of the business being subjected to change or extension a fresh charge

(*Continued on the last column of next page.*)

Foundry Purchasing.—XXVII.

By Eric N. Simonds.

Handling the Goods.

There are only a limited number of ways in which goods reach the consumer at a specific point. For most practical purposes aerial delivery can be eliminated, which leaves four means of arrival: through the works' gates by lorry, dray, or other conveyance; by parcel or letter post; by rail into sidings; and by steamer or barge into docks. In certain instances where goods are bought for resale, or on behalf of some external and usually overseas client, they may not be delivered to the buying firm at all, but may be forwarded direct by the supplier to specified destinations. In the last-named instances the goods have usually been inspected before dispatch, and at the manufacturer's works.

Saving Transport Costs.

The first point to bear in mind when arranging for the delivery or ordered supplies is to avoid unnecessary carting, transport, handling or other costs. For this reason, unless the character and arrangement of the foundry make it possible, a central weighing office dealing with every commodity delivered is inadvisable. Small firms, with but one gateway, must, of course, make do with one corresponding weigh office, and, in fact, do not need more. But where a large purchaser has several entrances and a large number of different departments, served by separate sidings, to insist on all the goods being brought to one central spot for weighing purposes would be to sacrifice valuable time and money. The goods, having been weighed, would often have to return on their tracks, causing waste motion of an expensive kind.

Broadly speaking, each railway sidings should have its weigh office, and any gate used for the passage inwards and outwards of transport vehicles should be similarly provided. In this way the goods on their arrival can be weighed at once, and forwarded without delay to their correct destination, whether this be the general stores or the consuming department. The weigh clerk can then proceed at once to notify the buying department of the receipt of the goods, and of their weight as recorded on his machine. This is important because unless prompt notification of discrepancies is made, the period during which claims are valid may expire, making it impossible for the buyer to obtain redress.

Classification of Incoming Materials.

Incoming materials can be divided for receiving purposes into three classes, as follows:—(*a*) Those to be delivered to consuming departments; (*b*) those to be delivered to the general stores or to a special storage dump; and (*c*) those to be set aside for inspection, analysis, or test. Each of these classes can be sub-divided according to whether the goods falling within its scope require weighing alone, counting alone, or both. Their reception varies again according to the manner of their delivery. All materials delivered by rail to sidings will need to be weighed, so that the traffic department can check the received gross and tare weights with the transport company's figures and with the supplier's advice note. Goods delivered by transport vehicle to the works or office entrance will, as a rule, only need to be weighed when their weight governs either the price or the terms on which they are purchased.

Importance of the Weigh Offices.

It will thus be seen that the function of the weigh offices is important, because on the accuracy of their work depends the detection of fraudulent practices on the part of suppliers; of loss in transit by railways, shipping companies or transport vehicles; of accidental short weight or surplus tonnage, and so forth. All scales and balances and weighing machines should be rigorously tested and examined periodically, a contract for this work being given out to trustworthy contractors. The weighmen should be conscientious and dependable men, especially chosen from among the ranks of old employees. They should be able to make clear and readable figures, since any ambiguity in outline may lead to unnecessary and provocative correspondence with suppliers, ending in undignified apologies. They will have to be methodical and of equable temperament, to enable them to deal with the draymen, lorry-drivers, labourers, and other refractory and difficult types with whom they will be continually brought into contact. And, above all, they must be honest and paid well enough to ensure their continuing so. It will readily be seen that weighmen have considerable opportunity for dishonesty since by making false returns or ignoring discrepancies, they can save fraudulent suppliers from considerable loss.

Methods of a Modern Weigh Office.

As the best means of outlining the work of a modern weigh office, it will be as well to describe briefly the system in force at one large foundry in the North Midlands. Here the problem is complicated by the existence of numerous works gates, all approachable by different main roads, and of three sets of sidings. The order forms issued by the buying department incorporate in their reference numbers an additional letter signifying the department to which the goods *are to be delivered*. This, it must be remembered, is not always the same thing as the department by which the goods were ordered, since a part required for a machine may be ordered by the department actually engaged in producing those machines, but the actual assembling may be done in another part of the works altogether. A copy of all orders is sent to the various weigh offices, minus whatever information (*e.g.*, prices) it is considered inadvisable to disclose. The order stipulates the department to which the goods should be delivered (if delivery is made by rail, the railway sidings connected with the railway serving the supplier or most convenient to the purchaser are specified), but when uncertainty exists as to the method of dispatch that the supplier will adopt, this stipulation is sometimes omitted. In many instances, suppliers either forget or deliberately ignore these instructions, especially in the case of deliveries by road-transport vehicle, and send the goods either to the wrong gate or to the wrong sidings. In such instances, the weighman to whom the receiving of the consignment falls is able to decide for what department they are required, by reading the order number quoted on the delivery slip presented by the drayman or lorry driver. Similarly, if the department to which delivery should be made is not mentioned on the copy of the order in his possession, he can gather it from the reference number. For example, if "C" stood for Machine Shop, any order numbered P/C/13467 would need to be delivered to the Machine Shop, and a glance would indicate this.

Why Goods should be Weighed.

The supplier who sends his materials by road usually hands to the driver or carter a delivery slip, to be signed by the weighman or receiver of the goods, and a duplicate of this is left with the weighman. Whenever this slip indicates a weight, even though the goods themselves may not be such as are bought by weight, the lorry and its contents are carefully weighed. The reason for this is that any discrepancy in weight between the supplier's record and the weigh office's result is the best guide to a corresponding discrepancy in quantity. For example, if a thousand brass castings have been ordered at a price of so much each, it might seem needless to check the weight of ten tons as indicated on the delivery note, since weight does not affect the price. But a discrepancy of half a ton revealed by the scales would suggest at once to the weighman that the consignment might not comprise the thousand castings it was supposed to comprise, and he would be able to draw the attention of the stores, or whichever department was responsible for counting the castings, to the need for extra care in this instance. On being counted, fifty castings might be missing, and investigations might prove either that the supplier was endeavouring to deceive the purchaser, or that the drayman himself was dishonest. Consignments of goods sold by weight are, of course, carefully checked over on the scales. Any serious deficiency is at once reported to the buying department, so that the latter may immediately get into touch by telephone or letter with the supplier.

After being weighed, the goods are sent forward to their destination, which may be either the raw material supply dumps, the stores, the offices, or the consuming departments. All materials needing inspection, analysis, and test are sent over to the stores. Each department is responsible for the unloading of its own goods from road vehicles, but material unloaded at the railway sidings is carted by the firm's own carters to the various destinations, which then undertake its further unloading. This is necessary, because railway companies now make up at their depôts truck loads of different materials for delivery to one consignee, instead of delivering each lot separately, so that one truck-load may contain materials for half a dozen different works departments. It has to be unloaded at once and its contents distributed.

Improved Methods and Lower Costs.

By Léon Thomas.

(*Continued from previous page.*)

on account of sinking fund, increase of rent, etc., can be applied at any time.

In the preceding notes the author has been able to sketch a general system of accountancy only in its main outlines. Its complexity, which is much more apparent than real, is due to the fact that it is supposed to be applied to a complete works. It would be considerably simplified for a foundry of medium size, but it was wished to show that a system whose principal object is to provide concrete facts and whose principal characteristic is accuracy must be designed in accordance with a logically conceived plan if it is to operate with the same regularity as the works whose economic progress it controls.

Conclusions.

In this Paper the author has endeavoured to show that in order to reduce costs it is necessary in the first place to be able to determine them, and that for this purpose a system of accountancy is necessary. It is indispensable that the products manufactured should be systematised; they must first be planned out and afterwards produced under the best conditions in respect of order, method and output.

The education of the foreman, staff and managers should be such as to give them correct ideas as to their duties in regard to their superiors and fellow-workmen. These results can be obtained only if all who co-operate in the enterprise possess in varying degrees a sufficient measure of independence according to the position they hold on the staff and also measure of responsibility.

The Americans owe their present undeniable superiority in the markets of the world to this clear comprehension of the apportionment of responsibility, together with their extreme devotion to specialisation and, it must be acknowledged, to their intensive methods of production, against which we can contend only by means of our (French) excessive protective duties, which are but a weak if not a dangerous barrier.

Let us improve and perfect our methods in order to reduce our costs. Let us reduce our costs in order to increase the general well-being and to be able to contend on equal terms with our competitors. These are the ends towards which all of us ought to strive who have the privilege of being manufacturers or direct workers in the economic system of our respective nations.

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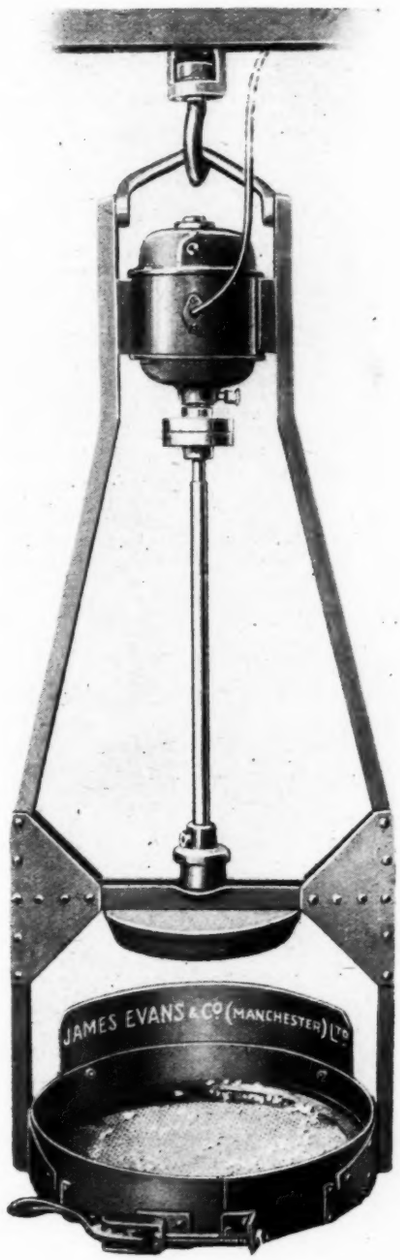

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Trade Talk.

Imports of iron ore into South Wales in June totalled 168,533 tons, of which 62,651 tons were discharged at Cardiff, 70,065 tons at Newport, and 35,817 tons at Port Talbot.

The recent cut of 2½ per cent. in wages accepted by the railwaymen is said to represent a saving of £2,500,000 in wages, to which must be added £2,700, representing an average cut of £30 in the case of 90 directors.

William Gray & Company, of West Hartlepool, have secured orders for three steamers for Spanish owners. The vessels are each 280 ft. long. They will be built at the firm's Central Shipyard and engined at their Central Marine Engine Works.

Messrs. Kincaid & Company, engineers, of Greenock, have received important contracts to engine and fit out six twin-screw motor ships. Three of the vessels are for British owners and three for foreign. The vessels will each be fitted with two sets of Diesel engines, indicating about 4,000 h.p.

An extraordinary general meeting of the Mond Nickel Company, Limited, held recently, confirmed the resolutions passed on July 12 providing for the sub-division of each of the existing £1 ordinary shares into two shares of 10s. each, and for the increase of the capital from £4,900,000 to £5,500,000 by the creation of 1,200,000 shares of 10s. each.

The month of July is usually a slack period in Clyde shipyards and engineering shops, work being suspended for about a fortnight for the annual holidays; output is, as a rule, well below the average. The output of the Clyde shipyards in July amounted to eleven vessels of 38,710 tons, bringing the total aggregate output for the seven months of the year to 127 vessels of a tonnage of 341,770 tons, compared with 120 vessels of 165,480 tons last year.

Contracts have been placed by the Central Argentine Railway with the Metropolitan Carriage, Wagon & Finance Company, Limited, of Saltley, Birmingham, for 30 motor bogie first-class coaches, and with Cammell Laird & Company, Limited, of Nottingham, for 13 first-class trailer coaches and six second-class trailer coaches. Eight "Mikado" type locomotives are being built by Messrs. Beyer, Peacock & Company, Limited, for the Buenos Ayres & Pacific Railway.

Shipments of pig-iron and manufactured iron and steel from Tees ports during July amounted to 75,436 tons, compared with 84,412 tons in June, a reduction of 8,976 tons. Of the total shipments, 53,516 tons went abroad, and 21,920 tons were shipped coastwise. Exports of pig-iron reached only 7,338 tons, and the coastwise deliveries amounted to 12,013 tons. The decrease in exports of steel during July were 13,000 tons, only 52,900 tons going to foreign destinations.

In the course of a letter to "The Times," Mr. Arthur Dorman (managing-director of Dorman, Long & Company, Limited), points out that the directors of the London & North-Eastern Railway Company stated that they were satisfied that the policy of quoting cheaper fares and providing increased facilities was the only policy which was calculated to rehabilitate the receipts from passenger traffic. Mr. Dorman argues that the extension of this policy to cover the heavy industries would tend ultimately to secure a similar result in the goods revenue.

The spirit of co-operation on the part of the London Midland and Scottish Railway Company with their traders is clearly shown in a report received from T. E. Gray & Company, Limited. Certain repairs being urgently necessary to the latter's boiler plant, the L.M.S. arranged a special service whereby the plant was received by the makers, Messrs. Ruston & Hornsby, Limited, at their Lincoln works, within ten hours of loading. The necessary work having been speedily carried out by the makers, a quick return of the plant was arranged by the railway company, enabling it to be put into commission again in record time. The value of such railway service is to be encouraged.

A further issue of the capital of the Crittall Manufacturing Company, Limited, makers of metal windows and other metal goods, is being made in the form of £750,000 of 6 per cent. five-year notes, which have been bought by the Anglo-Scottish Amalgamated Corporation at 96½ per cent., and are to be placed privately. These notes are not secured by any specific charge on assets of the company, but are protected by a trust deed which provides that, except for the £500,000 6 per cent. debenture stock already created, no debentures or debenture stock—other than charges to secure bank overdrafts—shall be created in priority to or *pari-passu* with the present note issue. The notes are redeemable on August 31, 1933, at 102 per cent.

Owing to losses caused largely by strikes, the Rees Roturbo Manufacturing Company, Limited, of Wednesfield Road, Wolverhampton, ironfounders and engineers, petitioned Mr. Justice Tomlin, in the Chancery Division, for sanction for a reduction of its capital from £250,000 to £112,561, by cancelling 19s. of each £1 issued ordinary share, and 10s. of each £1 issued preference share. It was stated that at the time the resolution for a reduction of capital was passed, £37,000 had been lost or was unrepresented by available assets. It had been agreed that the preference shares should carry 7½ per cent. interest, and be non-accumulative, but they would participate up to 10 per cent. in profits. The reduction and reorganisation of capital were sanctioned.

The question of a wages reduction was again under discussion at a conference in Glasgow between representatives of the National Light Castings Association and of the trade unions recently. The employers ask for a reduction of 10s. per week in the bonus paid to piece-workers and a relative revision of the rate paid to workers under 21 years of age. It is proposed to reduce wages of time-workers by 10 per cent. and of labourers by 2s. 6d. per week. A previous conference was adjourned to allow the men's representatives to consult their various unions. A ballot vote was taken, and the result was adverse to acceptance of the employers' scheme. The critical condition of the industry has again been stressed by the employers, who emphasise the necessity for assistance from the workers. To allow further discussions by the trade unions the conference was again adjourned until yesterday. The districts affected by the proposals are principally Falkirk and Bonnybridge areas and the Midlands of England.

Company Meetings.

W. H. Dorman & Company, Limited.—The ordinary general meeting of W. H. Dorman & Company, Limited, was held at the Institute of Chartered Accountants, Moorgate Place, E.C. Mr. Walter Haddon (the chairman and managing director), who presided, remarked that the company's affairs had improved since their last meeting. They had been able to pay their way, provide the usual depreciation out of revenue and finish up the year with a net profit of £10,280 18s., which was over £17,000 better than the previous year and nearly £30,000 better than the year before that. They would, of course, realise that the net profit earned during the year under review must be, according to law, applied to the reduction of the debit balance standing on the profit-and-loss account, and any future profits must also be dealt with in the same way until the adverse balance had been extinguished and the company's share capital was once more intact. The development of the foundry side of the business was proceeding on sound lines, and they looked forward to an expansion of that side of their activities.

Gloucester Railway Carriage & Wagon Company, Limited.—The 40th annual general meeting of the Gloucester Railway Carriage and Wagon Company, Limited, was held at Gloucester. The chairman, Mr. M. F. Maclean, who presided, said that they were able to present a distinctly better result than was the case 12 months ago. The balance of profit and loss brought into revenue was £57,409, compared with £10,699 last year. The balance of net profit was £51,229 compared with £2,554 last year. During the year in review, orders had been very scarce and competition very keen, and their manufacturing profit had consequently been very small. As they knew, one of their chief mainstays in bygone years had been the building of private-owner wagons, particularly for the coal trade; but this branch of the business was entirely suspended, and the bulk of their building was now confined to overseas passenger stock and a certain amount of goods wagons. Then, again, under happier conditions of trade, the home railways had been good customers for rolling-stock builders, but now they could not fully employ their own workshops. There were, they were told, indications of a general trade revival, but for those of them who were most directly associated with or, as in their case, dependent upon what were known as heavy industries, it was difficult to see any prospect of immediate improvement. They themselves could increase their production by 100 per cent. with practically no increase in overhead charges, so that the more they could produce the cheaper would be the cost of the finished article, and, as every builder of rolling-stock was presumably in the same position, it must necessarily follow that in the fight for orders prices would become unremunerative, and there could be little doubt that there was ample scope for judicious co-operation to try and check this suicidal policy.

The many friends of Mr. H. Cole Estep will be pleased to learn that he has been elected a director of the American Foundrymen's Association.

Personal.

Mr. Frederick Davies has been elected chairman of the East Ferry Road Engineering Works Company, Limited.

Mr. Arthur Seal Hider, of the Upton Foundry, Torquay (Messrs. G. E. Hider & Son) has accepted a position as mechanical engineer on the Gold Coast, and sailed for Accra on August 1. Mr. Hider is a member of the Institute of British Foundrymen, and has been instrumental in extending its influence in the West of England.

Mr. Thomas Bowton, furnace spare hand, of Lawn Terrace, Pontygof, and Mr. Thomas Philip Evans, furnace burden clerk, of Pennant Street, Ebbw Vale, have been awarded from the Carnegie Hero Fund an honorary certificate and £20 each for rescuing two men asphyxiated while cleaning an overhead gas main at the Victoria blast furnaces, Ebbw Vale. Both men have already been awarded the Edward Medal by the King.

Reports and Dividends.

Consett Spanish Ore Company, Limited.—Dividend of 4s. 6d. per share, less tax.

"Sentinel" Wagon Works (1920), Limited.—Interim dividend on preference at rate of 7½ per cent. per annum for six months ended June 30.

National Smelting Company, Limited.—Net profit, £176,092; dividend of 10 per cent. on both preference and ordinary shares; carry forward, £59,674.

Bristol & South Wales Railway Wagon Company, Limited.—Interim dividend of 5 per cent. (being at the rate of 10 per cent. per annum), less tax.

Birmingham Railway Carriage & Wagon Company, Limited.—Interim dividend at the rate of 6 per cent. per annum, less tax, on preference for half-year ended June 30.

North Central Wagon Company, Limited.—Profit, £39,687, including £11,155 brought in; final dividend of 9 per cent., making 15 per cent. for the year; reserve, £15,000; carry forward, £6,687.

Fodens, Limited.—Profit for year ended June 30 last, £25,579; with the amount brought forward, £39,029; dividend at the rate of 6 per cent., less tax, on ordinary, carrying forward, £24,274.

Book Review.

The Sales Engineer, by Gilbert Rigg.—Published by Mining Publications, Limited, 724, Salisbury House, London, E.C.2 Price 10s.

The first impression we received on opening this book was the prevalence of the capital I, but further perusal softens one, and the final conclusion reached is that sub-editing with a view to its elimination would spoil the book. The book is a sort of autobiography, wherein the author—an engineer (or is he really a metallurgical chemist?), details a number of experiences to justify a series of basic principles enunciated by him. The whole book, written in an easy style, reminds us of experiences we have all had when, comfortably seated in our own home or club, some brilliant engineer or metallurgist gives examples taken from his personal experience to lend weight to his arguments. In this book zinc and its products figures prominently, as the author has spent much of his time in this industry. He speaks of the help and inspiration he has derived from Dr. Rosenhain, Dr. Edwards, and his association with the A.S.T.M. His plea for the extension of the A.S.T.M. seems to us to be a slight on the B.E.S.A., which has done equally good work, or, again, has the author forgotten that the International Society for Testing Materials has been resuscitated? Candidly, we believe that it is the spirit of good fellowship he encountered at their meetings that the author would wish extended. We can assure him that if he will attend the provincial or foreign meetings of the Institute of British Foundrymen, the Iron and Steel Institute or the Institute of Metals, he will find just the same spirit of good fellowship being radiated from every corner of the smoking rooms during free moments. The best we can say of this little book is that it is written by "one of us for our benefit." It is the most "human" book of a technical character that we have ever handled.

ALUMINIUM CASTING ALLOYS

A REVIEW OF RECENT PROGRESS.

BY

GEORGE MORTIMER.

Read before
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Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—In accordance with traditional custom, business in the Cleveland iron market has been virtually suspended over the current holiday week. Unfortunately, there are but faint signs of any immediate improvement in the present position so far as conditions at home are concerned, furnace production having been further restricted in order to avoid the costly sequel of accumulated stocks with demand on a diminishing scale. Perhaps the only redeeming feature in the present situation is provided in the latest returns of Tees-side exports, shipments of pig-iron from the Tees in July having been the best for any month this year, and whilst it would be inadvisable to build too many hopes on what may be merely a fleeting improvement, there would appear to be possibilities of better trade overseas. There is, moreover, the prospect of reduced costs of production in December. Precisely to what extent the iron and steel trade will benefit from the lower railway rates on industrial fuel is not known, but to some extent costs will be reduced to the advantage of the industry generally. Prices for the present are firm and unchanged, as follows : No. 1 Cleveland foundry iron, 68s. 6d. ; No. 3 G.M.B., 66s. ; No. 4 foundry, 65s. ; No. 4 forge, 64s. 6d. per ton.

Production of East Coast hematite having now been curtailed, although there are ample stocks in hand, it is regarded as likely that as reserves dwindle prices will tend to harden. Indeed, certain firms are not inclined to accept below 70s. per ton for their special brands, although for ordinary mixed numbers 68s., and for No. 1 quality 68s. 6d., per ton are still the market rates. On the North-West Coast prices of Bessemer mixed numbers are weaker at 68s. per ton at works.

LANCASHIRE.—A slow inquiry and comparatively little actual buying continue the prevailing features in the local markets for foundry pig, with prices maintained at about recent levels as follows :—Derbyshire No. 3, 68s. ; Staffordshire, 67s. 6d. ; Cleveland, 79s. ; and Scottish brands at from 87s. 6d. to 90s., all per ton delivered Manchester or equal.

THE MIDLANDS.—For obvious holiday reasons business in the local markets for foundry material has been at a standstill during the current week, and prices are consequently unchanged as follows :—Northamptonshire No. 3, 55s. ; Derbyshire, 59s. to 60s. ; North Staffordshire, 60s. ; No. 3 Scotch, 88s. 6d. to 89s. 6d., delivered local stations.

SCOTLAND.—Following a general résumption of work after the holidays, as might be expected there has been a slightly better demand for pig-iron, and some of the furnaces which were damped down have been put into operation again. There is no change in prices, which remain steady on the basis of 70s. 6d. for No. 3 foundry, f.o.t. furnaces.

Finished Iron.

Manufactured iron is moving in no greater quantities than before, and on an average Lancashire makers are working their plant at no more than half capacity. The Association prices are well held, however, Lancashire crown quality bars being quoted here at £10 per ton and seconds at £9 10s. Merchant parcels of the former continue to be offered on the basis of 14s. per cwt., less 2½ per cent. and including delivery to buyers' works.

Steel.

The July figures of steel production will certainly tell a disappointing tale of restricted industrial activities. A good many steel furnaces are out of action and rolling plant is working intermittently on day-to-day orders. Still, there has been a faint improvement of late, due possibly to firmness of the Continental markets. Moreover, a few shipbuilding orders have been given out, whilst quite a large volume of inquiries is circulating for new tonnage. Hence the position is a little more hopeful, and makers are still firmly adhering to prices, which for the most part are fixed to home consumers by agreement. There has not been much business moving in the tinplate market, buyers refusing to commit themselves forward, and limiting their purchases to current requirements. Prices remain practically unchanged, with I.C. tinplates around 18s. 1½d. per box.

Scrap.

The position generally in the markets for foundry scrap material continues on the quiet side, with little change for the better expected until more settled conditions are assured. On Tees-side there is little demand for heavy cast iron, but an occasional purchaser of ordinary quality pays 61s., though 66s. per ton is still asked for machinery quality. In the Midlands, though the majority of foundries are not very busy, 65s. per ton delivered is still offered for heavy machinery cast-iron scrap in cupola sizes, and 52s. 6d. per ton delivered for the lighter qualities. There is a good demand for all classes of scrap for blast-furnace use. In Scotland the cast-iron scrap market shows no change, and it is difficult to dispose of practically all classes of this material. Heavy machinery is still being quoted at 65s. to 66s. per ton, and for heavy ordinary, cast in pieces not exceeding 1 cwt., 61s. 6d. to 62s. 6d. per ton. Old cast-iron railway chairs are quoted at 65s. to 66s. per ton. All delivered free at consumers' works.

Metals.

Copper.—Due in a measure to holiday influences, there has been a slightly weaker tendency in warrant copper values, but markets remain on the whole consistently steady. In the meantime the daily turnover is exceptionally small, and speculative interest is almost completely lacking. Values of standard and refined show a rather wide divergence for the moment, but this will doubtless be adjusted as business becomes more settled. The position on the New York market is much the same as here; demand and inquiry are dull, and prices firm.

Closing quotations are :—

Cash.—Thursday, £62 7s. 6d. to £62 10s. ; Friday, £62 10s. to £62 11s. 3d. ; Tuesday, £62 12s. 6d. to £62 13s. 9d. ; Wednesday, £62 7s. 6d. to £62 10s.

Three Months.—Thursday, £62 17s. 6d. to £62 18s. 9d. ; Friday, £62 18s. 9d. to £63 ; Tuesday, £63 to £63 2s. 6d. ; Wednesday, £62 16s. 3d. to £62 18s. 9d.

Tin.—Movements in standard cash values have again reflected an irregular tendency, though at the close an upward inclination was indicated, but whether this has resulted from revived speculative interest or whether it is the start of the inevitable, but long-delayed, appreciation in values, it is as yet too early to say. The general opinion is that a further period of uncertainty and fluctuation has to be faced before any degree of stability at higher levels is likely to be achieved. An interesting feature of the statistical position is the increased quantity of English tin which has recently become available and which has done something to ease the cash position.

Official closing prices :—

Cash.—Thursday, £214 10s. to £214 12s. 6d. ; Friday, £213 5s. to £213 7s. 6d. ; Tuesday, £213 7s. 6d. to £213 12s. 6d. ; Wednesday, £213 7s. 6d. to £213 10s.

Three Months.—Thursday, £213 5s. to £213 10s. ; Friday, £212 to £212 2s. 6d. ; Tuesday, £211 17s. 6d. to £212 2s. 6d. ; Wednesday, £211 17s. 6d. to £212.

Spelter.—The market for ordinary spelter, though quiet in the earlier stages, later developed rather more activity, and prices appreciated accordingly. As a result of the scarcity of near metal, the premium on forward was at one time eliminated, but at the close this stood at about 1s. 3d. On the Continent the position is governed by the Belgian producers' lack of anxiety to press supplies, although this is, of course, partly negatived by the general dearth of consumptive inquiry.

Daily quotations are :—

Ordinary. — Thursday, £24 11s. 3d. ; Friday, £24 13s. 9d. ; Tuesday, £24 12s. 6d. ; Wednesday, £24 10s.

Lead.—Although cable makers on the Continent and in Great Britain continue to take very considerable supplies, the current demand for lead still remains somewhat below the average. Slightly increased supplies are now coming to hand, and, although these are being fairly easily absorbed, values have reflected the consequent increased selling pressure and show a slight depreciation.

Closing prices :—

Soft Foreign Prompt.—Thursday, £21 ; Friday, £21 1s. 3d. ; Tuesday, £21 1s. 3d. ; Wednesday, £21 1s. 3d.

The Standard Copper Position.

By "Onlooker."

There seems to be very little hope of any improvement in the position of stocks of rough copper in this country, the total of which now stands in the neighbourhood of 7,000 tons, and, indeed, this time of the year, which is usually marked by buying by manufacturers of copper sulphate, is often responsible for depletion of English stocks. The weekly turnover on the standard copper market has latterly fallen to a figure which a year or eighteen months ago would have been covered by an average day's trading, and as long as reserves remain at vanishing point and the rigid control exercised by Copper Exporters, Inc., persists, there seems little hope of improvement. A rise in the price of electro has twice this year helped the standard market, but the improvement as short-lived.

Shortage of scrap, high prices for American Bessemer, and an acute scarcity of rough copper from Africa have all combined to cause a run on our reserves in this country, while a further cause of depletion has been heavy shipments to the United States refineries. This last transfer of copper was probably not unconnected with tactics of the Copper Combine, and may be said to have brought down stocks in this country well below the safety limit, but the root trouble of the situation is the fact that English smelters made practically no contribution last year to the world's copper production of unrefined brands, while imports from Germany and other countries were practically nil. The British copper trade on the production side has suffered a serious decline in the past ten years, and holds nothing like the relative position it formerly occupied.

The brands of Bessemer copper now reaching our shores from Chile are infinitely superior to the brands of rough copper lying in warehouse in this country, and although the price asked is certainly much higher, the quality is such that the metal can be utilised immediately for high-class work, such as locomotive fireboxes, etc. English rough copper, on the other hand, which assays usually about 96 per cent. and contains many impurities, is quite unsuitable for the manufacture of material required to conform to any sort of engineering standard specification, and, in consequence, a somewhat lengthy and expensive refining process is necessary to bring the copper up to the requisite pitch of purity.

Standard copper is a "good" delivery down to 97 per cent. pure, but below 97 per cent. to 94 per cent. allowances are made for "deficient produces," while anything below 94 per cent. is disqualified. As mentioned above, 96 per cent. is about the average, but manufacturers when buying run the risk of something worse unless an assay certificate is available, and the allowances made certainly do not cover the extra cost of refining away objectionable impurities. Such material compares very unfavourably with the general run of heavy copper scrap, H.C. wire, etc., which make up the old metal supplies in this country, and is indeed only one degree better than braziery copper, which comes at the end of the list of non-ferrous supplies.

At a time when every mining property is striving to improve the quality of its product and the general purity level of all non-electrolytically refined brands is very high indeed, the specification for the English standard brand remains in such a form that the copper conforming to it is placed at a hopeless disadvantage when compared with other rough coppers. Price is certainly a consideration to-day, but the day for "cheap and nasty" material has gone by, and that the best is cheapest in the end has become recognised in the metal trade as elsewhere. If the English standard market wishes again to rank high in the world of copper, it must rest upon a basis of material conforming to modern ideas of refining practice, and not lag behind hopelessly hindered by a specification which hampers it from the start.

Sterling

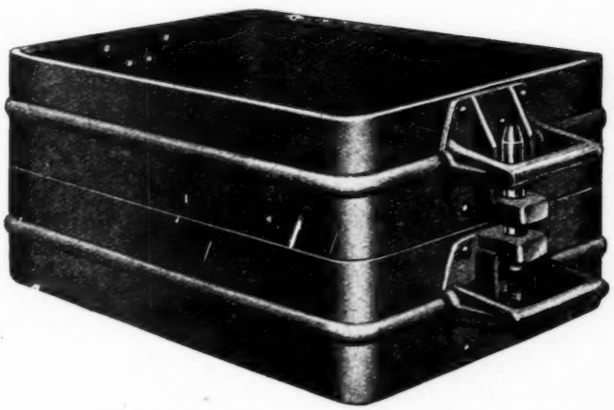
SOLID RIBBED ROLLED STEEL

MOULDING BOXES

are recognised as Standard Box equipment by the majority of the leading foundries and engineering establishments in this country and overseas.

Because they speed up production, save unnecessary labour, produce accurate castings and make for all-round efficiency.

If you are not a user of Sterling Boxes your competitors have the advantage of you.



STERLING FOUNDRY SPECIALTIES LTD.

London Office:
13, VICTORIA STREET, S.W.1.

BEDFORD.

Telephone : 3345 BEDFORD.
Telegrams : "STERFLASK, BEDFORD."
Code : WESTERN UNION.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	62	7	6
Three months	62	16	3
Electrolytic	68	15	0
Tough	65	0	0
Best selected	65	5	0
Sheets	94	0	0
India	76	15	0
Wire bars	69	5	0
Do. August	69	5	0
Do. September	69	5	0
Ingot bars	69	5	0
H.C. Wire rods	73	7	6
Off. av. cash, July	62	18	4 5/12
Do. 3 mths., July	63	3	9
Do., Sttlmnt., July	62	18	3 11/12
Do., Electro, July	68	18	4 1/12
Do., B.S., July	66	3	7½
Aver. spot price, copper, July	62	18	4½
Do., Wire bars, July	69	3	5
Solid drawn tubes			13½d.
Brazed tubes			13½d.
Wire			10d.

BRASS.

Solid drawn tubes	11½d.
Brazed tubes	13½d.
Rods, drawn	10½d.
Rods, extd. or rlld.	7½d.
Sheets to 10 w.g.	10½d.
Wire	9½d.
Rolled metal	9½d.
Yellow metal rods	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8½d.

TIN.

		£	s.	d.
Standard cash		213	7	6
Three months		211	17	6
English		211	10	0
Bars		213	10	0
Straits	(Nom.)	215	17	6
Australian	(Nom.)	215	17	6
Eastern		216	0	0
Banca	(Nom.)	216	17	6
Off. av. cash, July		212	10	11 13/32
Do., 3 mths., July		209	14	10 7/32
Do., Sttlmt., July		212	10	2 5/32
Aver. spot, July		212	10	11½

SPELTER.

Ordinary	24	10	0
Remelted	23	5	0
Hard	20	0	0
Electro 99.9	28	15	0
English	25	0	0
India	21	2	6
Zinc dust	33	0	0
Zinc ashes	8	0	0
Off. aver., July	24	19	2 5/16
Aver., spot, July	24	18	11

LEAD.

Soft foreign ppt.	21	1	3
English	22	10	0
Off. average, July	20	15	5 15/16
Average spot, July	20	11	11½

ZINC SHEETS, &c.

Zinc sheets, English	33	0	0
Do. V.M. ex whf.	31	2	6
Rods	39	0	0
Boiler plates	29	0	0
Battery plates	30	10	0

ANTIMONY.

Special brands, Eng.	59	0	0
Chinese	39	2	6
Crude	33	10	0

QUICKSILVER.

Quicksilver	21	17	6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro silicon—			
25%	8	0	0
45/50%	12	5	0
75%	19	0	0

Ferro-vanadium—	
35/40%	14/3 lb. Va.
Ferro-molybdenum—	
70/75% c. free	4/3 lb. Mo.
Ferro-titanium—	
23/25% carbonless	1/2 lb.
Ferro-phosphorus, 20/25%	£18 0 0
Ferro-tungsten—	
80/85%, c. fr.	1/3 lb.
Tungsten metal powder—	
98/99%	1/7 lb.
Ferro-chrome—	
2/4% car.	£30 0 0
4/6% car.	£21 0 0
6/8% car.	£20 10 0
8/10% car.	£20 0 0
Ferro-chrome—	
Max. 2% car.	£33 0 0
Max. 1% car.	£39 0 0
Max. 0.70% car.	£44 0 0
70% carbonless	1/2 lb.
Nickel—99% cubes or pellets	£175 0 0
Ferro-cobalt	9/- lb.
Aluminium 98/99%	£100 0 0
Metallic chromium—	
96/98%	2/8 lb.
Ferro-manganese (net)—	
76/80% loose	£13 15 0
76/80% packed	£14 15 0
76/80% export	£13 10 0
Metallic manganese—	
94/96% carbonless	1/6 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 3
Finished bars, 18% tungsten	£0 2 9

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 1/8 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ¼ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/-lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

Scrap from high-speed tool steel—	
Scrap pieces	3d.
Turnings and swarf	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Hvy. steel	3	7	6			
Bundled steel and shrngs.	3	2	6	to 3	5	0
Mixed iron and steel	3	0	0	to 3	2	6
Heavy cast iron	3	18	0			
Good machinery for foundries	3	2	6			
Cleveland—						
Heavy steel	2	15	0			
Steel turnings	2	8	6			
Cast iron borings	2	3	0			
Heavy forge	3	10	0			
Bushelled scrap	3	2	6			
Cast-iron scrap	3	1	0			
Lancashire—						
Cast-iron scrap	3	0	0			
Hvy. wrought	2	17	6			
Steel turnings	2	2	6			

London—Merchants' buying prices delivered yard.

Copper (clean)	52	0	0
Brass	37	0	0
Lead (less usual draft)	18	0	0
Tea lead	16	0	0
Zinc	16	0	0
New aluminium cuttings	66	0	0
Braziery copper	47	0	0
Gunmetal	47	0	0
Hollow pewter	150	0	0
Shaped black pewter	105	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	68/6
Foundry No. 3	66/6
Foundry No. 4	65/-
Forge No. 4	64/6
Hematite No. 1	68/6
Hematite M/Nos.	68/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	79/-
,, d/d Birm.	85/-
Midlands—	
Staffs. common*	67/6
,, No. 4 forge	56/-
,, No. 3 fdry.	60/-
Shrops. basic	—
,, Cold blast, ord.*	—
,, ,, roll iron*	—
* d/d Birmingham.	
Northants forge	52/6
,, fdry. No. 3	55/-
Derbyshire forge	59/-
,, fdry. No. 3	60/-
,, basic	60/-
Scotland—	
Foundry No. 1	75/6
,, No. 3	70/6
Hem. M/Nos.	74/-
Sheffield (d/d district)—	
Derby forge	62/6
,, fdry. No. 3	64/6
Lincs. forge	62/6
,, fdry. No. 3	64/6
E.C. hematite	78/6
W.C. hematite	84/-
Lincs. (at furnaces)—	
Forge No. 4	58/-
Foundry No. 3	60/-
Basic	58/6
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	68/-
Northants foundry No. 3	—
Dalzell, No. 3(special)	100/- to 102/6
Summerlee, No. 3	87/6
Glengarnock, No. 3	87/6
Gartsherrie, No. 3	87/6
Monkland, No. 3	87/6
Shotts, No. 3	87/6

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.) nom.	9	10	0	to 10	15	0
Nut and bolt iron	8	12	6	to 8	17	6
Hoops				11	10	0
Marked bars (Staffs.) f.o.t.				12	0	0
Gas strip				11	10	0
Bolts and nuts, ¾ in. × 4 in.				15	5	0
Steel—						
Ship plates	8	7	6	to 8	12	6
Boiler plts.				10	10	0
Chequer plts.				10	12	6
Angles				7	17	6
Tees				8	17	6
Joists				7	17	6
Rounds and squares, 3 in. to 5½ in.				8	17	6
Rounds under 3 in. to ¾ in. (Untested)				7	15	0
				and upwards		
Flats, over 5 in. wide and up				8	7	6
Flats, 5 in. to 1½ in.				7	17	6
Rails, heavy				8	10	0
Fishplates				12	10	0
Hoops (Staffs.)				10	0	0
Black sheets, 24g.				10	0	0
Galv. oor. shts., 24g.				13	10	0
Galv. fencing wire 8g. plain				12	10	0
Billets, soft	6	0	0	to 6	10	0
Billets, hard	7	2	6	to 7	12	6
Sheet bars				6	0	0
Tin bars				6	0	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 2½
Sheet to 10 w.g.	1 3
Wire	1 3½
Rods	1 3
Tubes	1 7½
Castings	1 2

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	20.26
No. 2 foundry, Valley	16.50
No. 2 foundry, Birm.	15.50
Basic	17.76
Bessemer	18.76
Malleable	18.76
Grey forge	18.01
Ferro-mang. 80% d/d	105.00
O.-h. rails, h'y at mill	43.00
Bess billets	32.00
O.-h. billets	32.00
O.-h. sheet bars	32.00
Wire rods	42.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.85
Tank plates	1.85
Beams, etc.	1.85
Skelp, grooved steel	1.85
Skelp, sheared steel	1.85
Steel hoops	2.20
Sheets, black, No. 24	2.60
Sheets, galv., No. 24	3.40
Sheets, blue an'l'd., 9 and 10	2.00
Wire nails	2.55
Plain wire	2.40
Barbed wire, galv.	3.20
Tinplates, 100 lb. box	$5.25

COKE (at ovens).

Welsh foundry	—
,, furnace	21/6
Durham and North.	
,, foundry	14/6 to 15/6
,, furnace	14/- to 14/3
Other Districts, foundry	—
,, ,, furnace (basis)	12/-

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes	20×14 box	18/- to 18/3
,,	28×20 ,,	36/6
,,	20×10 ,,	27/3
,,	18¾×14 ,,	19/-
C.W.	20×14 ,,	17/-
,,	28×20 ,,	34/-
,,	20×10 ,,	22/-
,,	18¾×14 ,,	15/9
Terneplates	28×20	34/- per box basis f.o.b.

SWEDISH IRON.

Bars, hammered, £17 10 0	to £18 10 0
Rolled Ord. £15 0 0	to £15 10 0
Nail rods £15 7 6	to £15 15 0
Keg. steel nom.	£33 to £35
Faggot steel nom.	£22 to £25
Blooms, according to quality	£8 to £12
Pig-iron £5 15 0	to £6 0 0

f.o.b. Gothenburg.

TUBES AND FITTINGS.
Up to and incl. 6 in.

	Tubes.	Fittings.
Gas	67½%	50%
Water	63¾%	45%
Steam	60%	40%
W.I. 10% extra.		

Electrolytic Copper.

	£ s. d.	
Aug. 2 ..	68 15 0	No change
,, 3 ..	68 15 0	,, ,,
,, 7 ..	68 15 0	,, ,,
,, 8 ..	68 15 0	,, ,,

Tin (English ingots).

	£ s. d.	
Aug. 2 ..	212 10 0	dec. 15/-
,, 3 ..	211 15 0	,, 15/-
,, 7 ..	211 10 0	,, 5/-
,, 8 ..	211 10 0	No change

Spelter (ordinary).

	£ s. d.	
Aug. 2 ..	24 11 3	No change
,, 3 ..	24 13 9	inc. 2/6
,, 7 ..	24 12 6	dec. 1/3
,, 8 ..	24 10 0	,, 2/6

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£ s. d.	
Aug. 2 ..	62 7 6	dec. 2/6
,, 3 ..	62 10 0	inc. 2/6
,, 7 ..	62 12 6	,, 2/6
,, 8 ..	62 7 6	dec. 5/-

Standard Tin (cash).

	£ s. d.	
Aug. 2 ..	214 10 0	dec. 15/-
,, 3 ..	213 5 0	,, 25/-
,, 7 ..	213 7 6	inc. 2/6
,, 8 ..	213 7 6	No change

Zinc Sheets (English)

	£ s. d.	
Aug. 2 ..	33 0 0	No change
,, 3 ..	33 0 0	,, ,,
,, 7 ..	33 0 0	,, ,,
,, 8 ..	33 0 0	,, ,,

Lead (English).

	£ s. d.	
Aug. 2 ..	22 5 0	No change
,, 3 ..	22 10 0	inc. 5/-
,, 7 ..	22 10 0	No change
,, 8 ..	22 10 0	,, ,,

AVERAGE MONTHLY PRICES OF DERBYSHIRE NO. 3 FOUNDRY AT MANCHESTER.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1895 ..	2 3 0	2 3 0	2 2 6	2 2 6	2 2 6	2 4 0	2 3 6	2 4 0	2 5 0	2 5 6	2 6 6	2 5 6	2 3 11½
1896 ..	2 5 6	2 6 0	2 6 0	2 6 0	2 6 0	2 5 6	2 5 0	2 5 0	2 5 0	2 6 0	2 7 0	2 8 6	2 5 11½
1897 ..	2 10 0	2 11 0	2 9 0	2 8 6	2 8 0	2 7 0	2 7 0	2 6 0	2 6 0	2 6 0	2 6 6	2 7 6	2 7 9½
1898 ..	2 7 6	2 8 0	2 8 0	2 8 0	2 8 6	2 10 0	2 10 0	2 10 0	2 9 0	2 11 0	2 14 0	2 14 0	2 9 11
1899 ..	2 13 0	2 14 0	2 14 0	2 14 0	3 0 0	3 2 0	3 13 0	3 16 6	3 15 0	3 16 6	3 16 6	4 0 0	3 6 2½
1900 ..	4 0 0	4 0 0	4 0 0	4 1 6	4 1 0	3 18 0	3 13 6	3 12 6	3 11 0	3 11 0	3 9 6	3 8 0	3 15 5
1901 ..	2 13 6	2 17 0	2 15 0	2 15 0	2 14 0	2 13 9	2 13 6	2 13 6	2 14 6	2 13 0	2 12 6	2 16 6	2 14 3½
1902 ..	2 17 6	2 17 6	2 15 6	2 16 9	2 16 6	2 16 6	2 16 6	2 17 0	2 18 6	2 18 6	2 17 6	2 17 6	2 17 1½
1903 ..	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6
1904 ..	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6
1905 ..	2 13 0	2 13 0	2 11 6	2 12 6	2 12 0	2 12 0	2 12 3	2 12 3	2 14 0	2 16 6	3 0 0	3 0 6	2 14 1
1906 ..	3 2 0	3 5 0	3 3 0	3 0 6	2 17 0	2 18 6	2 18 0	2 16 6	2 19 0	3 0 6	3 1 6	3 7 0	3 0 8½
1907 ..	3 7 0	3 7 0	3 5 0	3 2 0	3 4 0	3 8 0	3 6 0	3 5 0	3 4 0	3 2 6	3 1 0	2 18 6	3 4 2
1908 ..	2 15 0	2 14 6	2 14 6	2 15 6	2 14 0	2 13 0	2 13 0	2 11 6	2 12 6	2 13 0	2 12 6	2 12 6	2 13 5½
1909 ..	2 13 0	2 12 6	2 11 6	2 12 0	2 12 6	2 12 6	2 12 0	2 12 6	2 14 6	2 15 0	2 14 6	2 14 0	2 13 0½
1910 ..	2 13 9	2 14 0	2 14 0	2 14 4	2 15 6	2 15 6	2 14 9	2 15 0	2 15 0	2 15 0	2 15 0	2 15 0	2 14 7½
1911 ..	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 14 6	2 15 0	2 15 0	2 15 8½
1912 ..	2 17 4½	2 17 6	2 17 6	3 1 1½	3 2 6	3 3 9	3 6 3	3 7 6	3 10 10½	3 12 6	3 13 3½	3 14 6	3 5 4
1913 ..	3 15 7	3 15 0	3 11 10½	3 11 4½	3 10 2½	3 6 10½	3 4 2½	3 2 9	3 1 9	3 1 0	2 19 3	2 17 2½	3 6 5
1914 ..	2 17 2½	2 18 0	2 18 0	2 17 0	2 17 0	2 16 7½	2 16 0	3 2 10	3 1 0	2 19 9½	2 16 11½	2 18 1½	2 18 2½
1915 ..	3 1 2	3 3 11	3 5 9	3 18 8½	3 13 7	3 14 1	3 15 0	3 13 3	3 12 0½	3 11 1	3 14 0	4 3 3	3 12 2½
1916 ..	4 4 6½	4 11 6	4 11 6½	4 7 6	4 7 6	4 7 6	4 10 0	4 12 10	4 12 6	4 12 6	4 12 6	4 12 6	4 8 6½
1917 ..	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6
1918 ..	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6
1919 ..	4 12 6	4 12 6	4 12 6	4 12 6	7 2 6	7 5 0	8 8 5	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	7 3 10
1920 ..	9 13 9	10 0 0	10 5 3	10 15 3	11 10 0	12 2 6	12 5 0	13 1 3	14 7 6	14 5 0	14 5 0	14 5 0	12 12 1½
1921 ..	12 11 8	10 8 9	9 2 6	8 2 0	8 0 0	8 0 0	8 0 0	8 1 8	7 4 0	6 7 6	5 7 6	4 16 10	8 0 2
1922 ..	5 5 0	4 17 6	4 15 0	4 15 0	4 12 6	4 12 6	4 12 6	4 11 3	4 10 0	4 10 0	4 10 0	4 10 0	4 13 7½
1923 ..	4 12 8½	5 0 2	6 2 6	6 8 7½	6 2 5	5 11 9	5 9 1½	5 4 0	5 0 0	5 0 9	5 0 7	5 2 9	5 7 11½
1924 ..	5 3 0	5 3 0	5 3 0	5 3 0	5 2 10	5 1 3	4 17 11	4 15 6	4 13 6	4 10 1½	4 10 0	4 10 3	4 17 9½
1925 ..	4 10 0	4 9 0	4 6 9	4 5 2½	4 3 0	4 0 1½	4 17 1½	3 15 7½	3 14 3½	3 13 4½	3 13 4½	3 13 2½	4 1 9
1926 ..	3 14 9	3 15 3	3 15 6	3 15 3½	3 17 6	4 5 9	4 16 9	*	*	*	*	4 12 6	4 0 1½
1927 ..	4 13 9½	4 13 3	4 11 1½	4 9 4½	4 6 1½	3 19 1½	3 16 1½	3 15 6	3 13 4½	3 13 4½	3 14 0	3 13 6½	4 1 6½
1928 ..	3 13 2½	3 12 3½	3 12 3	3 12 3	3 11 6	3 10 0	3 8 3	—	—	—	—	—	—

* No price available during strike period.

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

PIG IRON

REGISTERED TRADE MARK

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

19, ST. VINCENT PLACE, GLASGOW.

ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

Notice.

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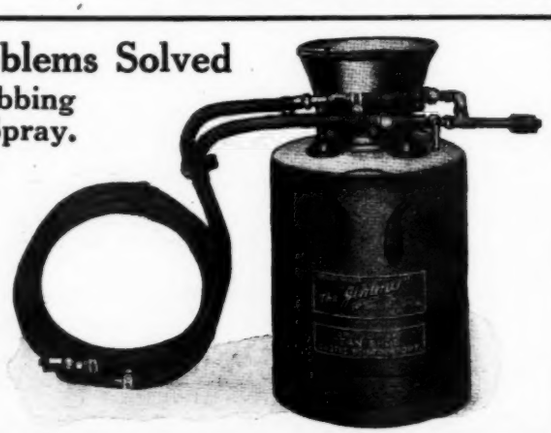

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